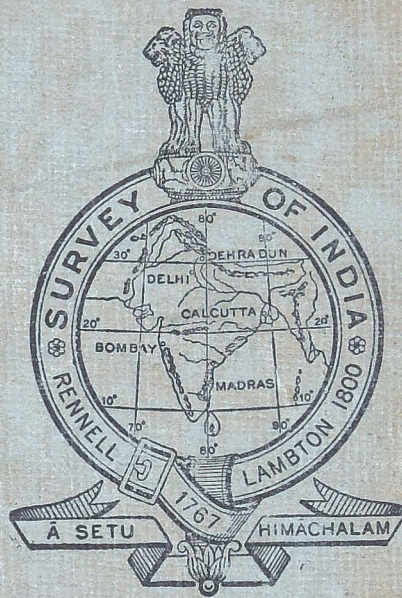


THE SURVEY OF INDIA  
DURING WAR AND EARLY  
RECONSTRUCTION  
1939-1946



By BRIGADIER SIR OLIVER WHEELER, M.C.  
DIRECTOR FRONTIER CIRCLE 1939-41, SURVEYOR GENERAL 1941

PUBLISHED BY ORDER OF  
THE SURVEYOR GENERAL OF INDIA

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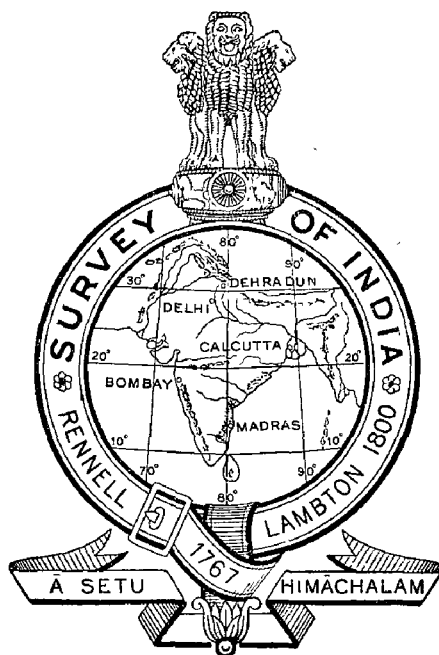
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# THE SURVEY OF INDIA

## DURING WAR AND EARLY RECONSTRUCTION

### 1939-1946



By BRIGADIER SIR OLIVER WHEELER, M.C.  
DIRECTOR FRONTIER CIRCLE 1939-41, SURVEYOR GENERAL 1941-46.

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**THE SURVEY OF INDIA**  
**1939-1946**







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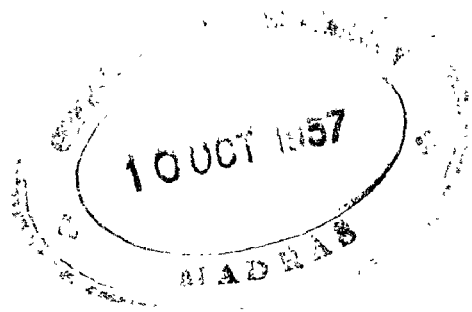
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10 OCT 1957

MADRAS

## FOREWORD

Brigadier Sir Oliver Wheeler, M.C., assumed the office of Surveyor General of India in April 1941. Prior to that he had held the appointment of Director, Frontier Circle, Survey of India.

At that time the Military Survey Service did not exist and all military liaison with the Armed Forces on survey and mapping matters, all survey preparations and training for war and the raising of military survey units were the responsibility of the Frontier Circle. Brigadier Wheeler was, therefore, intimately connected from the first with the problems raised by the impact of war on the Survey of India ; and it fell to him to provide their solutions. He continued in office during the whole war and until about 15 months after V-J day.

The imminence of the return of peace presented a new set of problems as it was evident that, for some years at least, the post-war rôle of the Survey of India would be very different from its pre-war rôle. This resulted from the urgent demands of post-war India for surveys for development projects to increase the resources of the country in both food and power ; and the fact that the Survey of India was the only organization capable of undertaking these surveys.

To meet these new problems, fresh organizations and methods had to be evolved and as the end of hostilities drew near increasing attention had to be paid to them.

As a result of the war it had been impossible to continue the issue of the routine reports of the activities of the Survey of India after 1941. The depleted staff remaining with the Department was much too busy, and in any case much of the essential information could not then have been published for security reasons.

After the war, with the retirement of most of the senior officers who had remained with the Department during its whole period, it became evident that the story of the Survey of India during these interesting and exciting times would never be told unless someone volunteered to do it in retirement. Brigadier Wheeler with his unrivalled knowledge of all that had happened was the obvious person for the task and generously volunteered to undertake it. The present volume has been written during his retirement in Canada. A certain amount of editing and the collection of some information for the appendix and tables has been undertaken in India. Demands on the limited publication resources of the Survey of India have delayed publication. For this the author is not to blame.

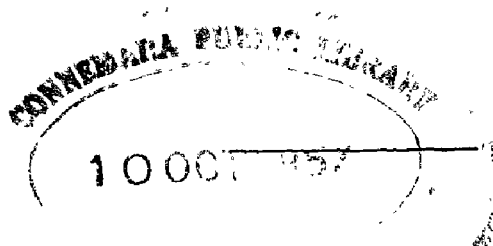


Ten months after Brigadier Wheeler's retirement, the Department of which he had been the head was divided between India and Pākistān. This has resulted in much information which might have been of interest for this book, not being available.

History never repeats itself exactly, and the problems and conditions which confronted the Survey of India at the beginning and end of the Second World War are unlikely to recur in the same form. The experience gained in these times is nevertheless likely to be of considerable lasting value to those concerned with survey matters ; and it is hoped that the inherent interest of the record will appeal to a wider circle of readers.

MUSSOORIE, U.P.  
October 1950.

G. F. HEANEY,  
*Brigadier,*  
*Surveyor General of India.*



10 OCT 1957

MADRAS

## PREFACE

As its title implies, this book covers not only the actual war period 1939–45 but also the following year during which demobilization was in progress concurrently with the initiation of a number of very large reconstruction and rehabilitation projects and the execution of many smaller projects urgently needed in connection with short term “grow-more-food” plans.

The first full scale post-war field season was that of 1946–47 ; even then, many officers and other ranks of the Survey of India were still in the army and the Department was publishing large quantities of ex-India maps demanded by the army.

It is not possible or perhaps desirable to describe the work of the Survey of India exclusively from the military point of view ; not only would coherence be lost but certain civil activities had to go on during the currency of the war and in fact some of these activities served military ends, such as the Hazāra Settlement Survey ; on the other hand, certain military work such as research in astro-fix methods led to improvement of methods for post-war civil surveys.

I have, therefore, described the whole work of the Department during and immediately after the war and have tried to show the inter-connection between civil and military work ; in brief, the war effort of the Survey of India.

In the earlier part of the war, military survey units were formed by the Survey of India almost wholly from its own personnel ; the fortunes of these units are followed overseas to some small extent. Later, units and survey headquarters in India and SEAC become very mixed—some Indian some British personnel ; some Survey of India some non-Survey of India personnel—and were not formed by the Department as such, though much of this personnel was trained by it.

In reading this book it has to be remembered that except for the Artillery Survey Section, R.A. the Survey of India was the sole military survey organization in India when the war broke out and had for many years followed a semi-military tradition, undertaking to train and supply certain military survey units, fully equipped with technical instruments and equipment, when required to do so. Its senior officers were nearly all soldiers and it had on its strength a considerable number of surveyors who were soldiers or ex-soldiers.

In the first part of the book, Chapters I to XII inclusive, I have put down a brief chronological record of the position in which the Survey of India found itself when the war began, its development into a strong base and supporting organization for the military



survey services created during the war and its ultimate transition, not yet complete in 1946, into a strong post-war reconstruction organization. There is no index to this part but in the succeeding part, "Annotated Index and Glossary", each subject likely to be of interest to any reader whether layman or surveyor has been briefly dealt with as such; this is arranged in alphabetical order and it is hoped is sufficiently comprehensive, cross referenced as it is, to give reasonably full and coherent information on each individual subject connected with the war and early reconstruction. The tables and appendix give some further details on certain subjects and some statistics.

Because some readers may not be familiar with Survey of India procedure and nomenclature, the alphabetical section is also designed to serve the purpose of a glossary.

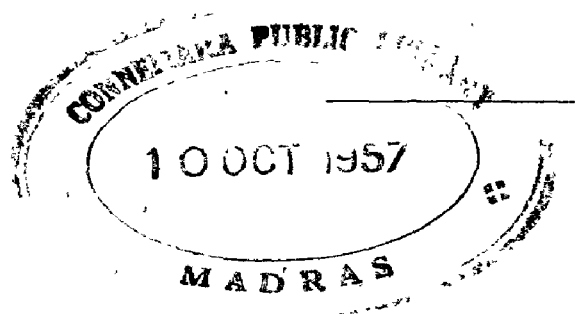
This method necessarily causes some repetition.

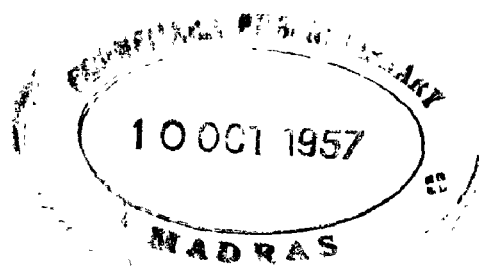
Technical methods have not been described in any detail but references to various Departmental publications have been made, which will make it possible for those interested to obtain more information if they desire it.

A review of scientific work carried out between 1939 and 1947 is contained in the Technical Report of the Survey of India, Part III—Geodetic Work, published 1948.

KELOWNA, B.C., CANADA,  
1949.

E. O. WHEELER.





## CHAPTER I

### INTRODUCTORY

1. **Early history of the Survey of India.**—To appreciate fully the somewhat complex role played by the Survey of India in the 1939–45 war it is necessary to have some knowledge of its history, its aims and its organization. Affectionately known to its members as “The Department” and frequently so-called in this book, the Survey of India is a department under the control of, but not of, the Government of India. For a number of years preceding the late war and during most of its currency the Survey of India functioned under the control of the Department ( “Ministry” ) of Education, Health and Lands of the Government of India coming, however, under the control of the Department of Agriculture after the government reorganization in 1945, when Education, Health and Lands divided into three separate departments ; it has never, at least during the present century, worked under the control of the Defence or War Departments of the Government of India, notwithstanding that a fair proportion of its personnel was or had been soldiers. This personnel was seconded, or lent, to the civil survey department and was administered under Civil Service rules.

2. A Surveyor General of Bengal, a military officer, was appointed by Clive in 1767, a Surveyor General of Bombay being appointed in 1796 and of Madras in 1810. In all three Presidencies surveys had been carried out both in conjunction with military operations and under purely civil arrangements, the latter mainly for revenue purposes ; in 1815 a Surveyor General of India was appointed with headquarters at Calcutta to control and co-ordinate the work of the three Presidencies. Revenue work, however, remained the responsibility of the Presidencies in Bombay and Madras ; only in Bengal was revenue work carried out under the orders of the Surveyor General of India, eventually extending north and west to the outlying areas of the Punjab and Sind.

In 1800, an independent Trigonometrical Survey was formed under the control of the Madras Government, transferred in 1818 to the control of the Supreme Government under the name “Great Trigonometrical Survey of India” and in 1823 to the control of the Surveyor General of India. The three branches, trigonometrical, topographical and revenue, were amalgamated in 1878 under the title “Survey of India”.

In 1833 the Trigonometrical Survey moved to Dehra Dūn, where it still remains under the name Geodetic Branch, but it was not till 1940 that the headquarters of the Surveyor General moved from Calcutta to Delhi though the Surveyor General himself moved there in 1939.

3. Between 1823 and 1905 a network of first quality triangulation and levelling was established over India and much of Burma ; it was during this period that Mt. Everest, named after the Superintendent of the Great Trigonometrical Survey, was discovered to be the highest mountain in the world and during this period too that so much fine work was done by Indian explorers in Tibet and other areas adjacent to India, described in the *Records of the Survey of India*, Volume VIII. Exploration surveys were usually undertaken by the G.T.S. ( now Geodetic Branch ) and it was for this reason that what material existed for the mapping of countries adjoining India was housed at Dehra Dūn when it became necessary to use it during the 1939-45 war. Military and other personnel of the Department also accompanied many military expeditions and missions both to assist the troops on the ground and also to take advantage of their presence to extend exploration.

Topographical and revenue surveys progressed well during this period and many maps, both topographical and geographical, were published ; almost entirely, however, in black only with hachures or form lines instead of contours. These surveys were based on the high quality triangulation and levelling of the Great Trigonometrical Survey. Early in this period a high proportion of the personnel was military and much of it imported from Britain ; gradually, the proportion of civilian officers and men recruited and trained in India was increased though military strength remained considerable up to 1905 and even later.

It is interesting that the first postage stamps issued in India, in 1854, were printed by the Survey of India publication offices in Calcutta ; while in 1942 certain "fake" documents were printed in the Map Publication Office in Calcutta, for anti-Japanese espionage purposes.

4. 1905-1914.—In the early part of the present century, there were complaints from the military authorities that Survey of India maps were not "modern", that topographical ( military ) surveys were progressing too slowly and that revenue surveys, much in demand as India developed westwards, were given too much prominence in the Department's programmes.

These complaints resulted, in 1905, in the convening of a committee composed of high civil, military and departmental officers as well as advisers from the Ordnance Survey of Britain to formulate a policy and programme that would meet military needs while still meeting civil needs—except for revenue surveys which, from that time, became the responsibility of the provinces. The policy and programme, to cover India in 25 years with modern coloured and contoured maps, was approved by the Government of India and the Secretary of State for India, and put into effect at once, military surveys being commenced on the West and North-west Frontiers. "Modern" printing machinery was installed in the Calcutta offices and colour printing technique introduced.

Topographical surveys progressed rapidly during the next few years and many maps, contoured and in colours, were published on a new ( the present ) lay-out as devised by the committee of 1905-06. The various map series established at this time, practically speaking those with which we entered the war 1939-45, are discussed in Chapter III following.

5. The War, 1914-1918.—On the outbreak of war in 1914, a large proportion of the Department's military officers, some 60 all told, was reverted to military duty for regimental ( non-survey ) employment ; some civilian officers who were members of the Reserves of Officers were also called up for military ( non-survey ) duty. This left the Survey of India very short-handed in officers and the internal survey programmes were much slowed down ; a number of surveyors and others, too, went to military duty. The necessity for comprehensive survey and mapping work in any major war and during the reconstruction period after it had not been recognized, with its consequence—the dissipation of highly trained and experienced personnel, particularly officers.

When the war developed to large proportions in Mesopotamia, a virtually unmapped country, the need for survey personnel became intense. With some difficulty, for a number of officers had been killed or had become key personnel in non-survey employment, a strong survey service was formed from Survey of India personnel to function in Mesopotamia and also in west and east Persia. It was, of course, necessary to have Hindustāni speaking officers ; apart from that, the Ordnance Survey of Britain and their Dominion and Colonial counterparts had their hands full with their own problems in Europe and Africa.

The survey material gathered in Mesopotamia and in west and east Persia proved of very great value in the 1939-45 war during the occupation of 'Irāq and Irān.

The Survey of India's part in the 1914-18 war is described in Volume XX of the *Records of the Survey of India—The War Record*.

6. 1918-1925.—Between 1919 and 1922 recruitment of both military and civilian officers was heavy, to fill the gaps caused by the war and to make up for short recruitment during that period. This necessitated heavy training programmes concurrently with attempts to catch up on the much delayed topographical programme and the pre-war officers of the Department had a heavy task supervising the work of semi-trained officers in charge of camps and parties.

The authorized strength of the Department remained practically as before the 1914-18 war but it was not found easy to fill all military vacancies, mainly due to a revision of pay that occurred in 1920, making employment in the Survey of India much less advantageous financially than it had hitherto been.

7. At the same time it was recognized that even in small wars strong survey and map publication potential with the fighting forces

would be necessary in the future and that the system used in Mesopotamia, virtually civil units whose members held "relative military rank", was not easily workable where large military forces were employed. The development of aircraft during the war and the use of air photographs for mapping in all the war theatres had also shown the necessity for research and training in air survey methods; experimental work in this branch of surveying was carried out in 1921 and a large survey (the Irrawaddy Delta) undertaken in 1922-23.

8. **The Frontier Circle.**—This Circle of the Survey of India was created in 1925 with its headquarters and drawing office at Simla in close touch with Army Headquarters and its major field units, "A" and "E" Companies and No. 18 ( Air Survey ) Party located respectively at Murree, Quetta and Peshāwar (later Risālpur) in touch with Northern and Western Commands and the R.A.F. These units carried out the topographical work of the Circle, which was responsible for most of north-west India, besides organizing and training for war; No. 18 Party concentrated on air survey research and training and the mapping of Tribal Areas hitherto unmapped or badly mapped due to inaccessibility on the ground.

"E" Company was also utilized at the outset for the standard departmental training of officers and other ranks because of the all year round terrain about Quetta; this however, was found in the end to be too expensive, due to the distance of Quetta from the main part of India and the fact that in much of the area of Baluchistān tribal escorts were necessary for surveyors in the field. Large numbers of Indian Army personnel were, however, trained in "E" Company, coming from the Indian Military Survey course at Roorkee, and these men formed the backbone of our experienced soldier-surveyor cadre in the 1939-45 war.

The Director, Frontier Circle was *ex officio* map and survey adviser to the Commander-in-Chief in the latter's capacity as head of the military forces in India; the Surveyor General was his official adviser in the C.-in-C.'s capacity as head of the Defence Department of the Government of India; similarly, the officers in charge of "A" and "E" Companies and No. 18 Party were local advisers respectively to Northern and Western Commands and the R.A.F.

9. Numerous training exercises were carried out between 1926 and 1930 in co-operation with the military commands on the Frontier and in particular with the Artillery Survey Section, R.A., Kakul. These varied from full scale exercises with troops, to TEWTS and staff exercises, and a considerable proportion of the Department was trained in the elements of air survey in No. 18 Party; the most receptive were retained for longer periods in 18 Party, for productive work.

War establishments and war equipment tables were worked out and terms of service for Survey of India personnel in war adumbrated along with those for the Railways and other major services that would be, in effect, mobilized in war. These reached finality in 1934—only to be completely scrapped immediately the war broke out in 1939, when we started afresh from scratch.



Mobilization schemes too were prepared, never—except as a general guide as to what was required to be done—to be used. These schemes of course were based on the assumption that the Survey of India would supply units for a war on the North-west Frontier of India ; they were not designed for full scale world war.

During this period, other parties were formed under the administrative control of the Frontier Circle, mainly to carry out special surveys for rapidly expanding irrigation projects in the Punjab and Sind.

10. 1930-1938.—When the world depression struck India in the early thirties, retrenchment became the order of the day. The Department was cut nearly in half, indeed barely escaped dissolution ; military exercises—“spending” works—were frowned upon and the Survey of India, as other central departments, sought for “paid-for” works, such as irrigation surveys, settlement surveys and the like required by the provinces. The topographical programme, already much slowed down by the 1914-18 war and its aftermath, became still more in arrears ; it was clear that there was no chance whatever of completing the “modern” survey of India in anything like the 25 years originally specified ( para 4 ) and still less, with the curtailed personnel and funds, of keeping up-to-date such maps as we had.

This led to much research in the methods that might be used to keep maps up-to-date—the surveyor’s bugbear—and to consideration of what map series might be dispensed with and what colours on the maps ; at this time, maps were printed in up to seven or eight colours, involving, with the machinery at our disposal, up to ten different printings for each map. The research, however, stood us in good stead during the 1939-45 war, as did the fact that shortage of funds compelled us to concentrate on improving our compiled maps, done in the office, instead of making new maps in the field where transport and other field expenses were always heavy.

During this period the army treated maps as very precious things, not to be expended ; map stores were full of out-of-date and part-worn maps many of them on linen backed paper ( very bulky and expensive ) or on “Jap” paper, a paper that does not tear easily but possesses no other merit. Orders for maps were few and small and it was seldom that more than 500 copies were printed of any map on first publication or re-publication ; press orders up to 10,000 were the routine during the war that followed.

11. By the end of 1938 however, rumours of war stirred up mobilization plans again and hence training. A very comprehensive exercise, full scale, was carried out in co-operation with the Artillery Survey Section, organized by the Brigadier, R.A., in Northern Command. The Survey of India put a practically complete Field Survey Company in the field, less shortages in equipment due to the previous financial stringency. The exercise was of the greatest value and resulted in recasting of War Establishments and War Equipment Tables to meet modern conditions as envisaged primarily

on the North-west Frontier of India but also with wider scope and the North-east Frontier in mind. Two officers of the Survey of India were on the directing staff of this exercise, which lasted 5 days apart from two or three weeks preliminary departmental exercises.

The theme of the exercise was the preparation of a one-inch scale topographical map as well as a battle map on 1/25,000 scale by air survey methods, controlled by rapid triangulation during the course of which triangulated values (trigs) were given to the Artillery from day to day, to facilitate surveying in their gun positions and targets in terms of the general topographical map and ultimate battle map. Publication of the maps was carried out on plant in Risālpur that fairly simulated plant likely to be available with forward survey troops in war. Portable plant (fitted for mule transport) was also utilized.

12. 1939.—So far as topographical survey work was concerned, the field season 1938-39 was a slim one by comparison with the preceding three years and the 30 years ending 1933 that inaugurated the 1905 Committee's recommendations for a topographical programme. From 1938-39 until the end of the war, topographical survey progressively reduced until it practically faded out, as is mentioned in more detail later on. On the other hand, compilation work in the drawing offices and in parties that did not take the field increased (para 10) and publication still remained a bottle-neck, resulting in five modern auto-feed rotary offset printing machines being ordered from England together with some ancillary equipment; and in the number of map series to be maintained being reduced and the colours in which many maps were printed being drastically reduced, together with plans for quicker revision of existing maps, reflected in the revision out-turn of 1939-40, a total of about 8,800 square miles in India and Burma as compared with about 800 in 1938-39.

"Paid-for" work was in good standing in 1939, a precision survey of Lahore being in hand along with several irrigation and similar surveys, with more precision city surveys in demand.

As before 1905, the pendulum had swung towards revenue work, to conserve Central Government funds. In 1939 this was offset by the evident possibility of war, giving impetus to military training and to setting our house in order in respect of mobilization stores, map publication potential and the like.

13. As usual in the hot season, a number of officers were on leave in U.K. during the spring and summer of 1939. These officers were all recalled to India during September immediately after war broke out. I had been Director, Geodetic Branch at Dehra Dūn from the spring of 1938 and was supposed to have taken over Director, Frontier Circle at Simla early in 1939; the unexpected emergency leave of the Surveyor General (Brigadier C. G. Lewis) however resulted in my having to officiate for a time as Surveyor General, in Calcutta, and it was not till May 1939 that I joined the Frontier Circle, though I was fully familiar with Frontier Circle requirement

after six years in command of "E" Survey Company at Quetta and more recently, as a member of the directing staff of the military training exercise held late in 1938 ( para 11 ).

14. When the war started, the usual arrangements were in train for organizing the field survey season for 1939-40. Some further curtailments were made resulting in a very small topographical programme even by comparison with 1938-39.

Little geodetic field work was in progress, due to financial stringency, the major works being gravity measurements in Burma and levelling of high precision in eastern India ; a project to connect two north-south geodetic triangulation series by an east-west geodetic traverse had been shelved in 1938-39 and was again shelved in 1939-40. As it turned out however, methods not unlike those proposed for this traverse were utilized during the war.

Computational work was heavy and the Geodetic Branch therefore commenced the war with a reasonably strong staff of trained computers, which was fortunate.

15. Another military exercise was held late in 1939 in co-operation with the Artillery Survey Section, preceded by the test mobilization of a Field Survey Company and about a month's unit training. This training, which was attended by a large proportion of the military officers of the Department either as participants or spectators, brought to light further faults in organization and methods that we sought to put right immediately after the conclusion of the combined exercise.

Arrangements were also in train at this time to mount on trailers two double-demy hand-feed rotary offset machines that had been purchased earlier for military purposes ; the necessary tractor-trailers were hard to come by. In all, there were four such rotary machines in the Department two being in Calcutta, one in Dehra Dūn and one in Quetta ( under transfer to Risālpur ). There were only two other rotary machines in the Survey of India ( at Calcutta ) the remainder of our printing machinery being flat-bed. Flat-bed machines require different printing plates from rotaries and this caused some trouble in the earlier stages of the war as modern rotary machinery superseded the out-moded and worn out flat-beds.

16. As mentioned in the preface, there is no formal index to this book. Instead, there is an "annotated index and glossary" which may be consulted for further details on the various subjects mentioned in this first, chronological portion—and for continuity on each particular subject throughout the whole period covered by the book. This "index" is heavily cross referenced and in a few cases where there is more detail in this first portion, is referenced back to it.

## CHAPTER II

### INTRODUCTORY—( *continued* )

17. **Methods of topographical survey.**—From its earliest days, the plane-table had been the instrument most used by the Survey of India for its topographical surveying and indeed for irrigation and other similar surveys at least in part ; the Department possessed some of the world's finest plane-tablers. These men were officially designated "surveyors", a misleading term because, at least under modern conditions, a "surveyor" is presumed to know a good deal about all branches of surveying, which our plane-tablers did not. This frequently led to confusion when the Department was asked for help by outside bodies, both civil and military. In the Survey of India, it was the *officers* who knew about all branches ; the rank and file were in a large measure specialists in a single branch of surveying such as plane-tabling, traversing, levelling and so on.

This system arose from the fact that much of our field staff was recruited from sources similar to those used by the army ; the staff had to be really tough and hard physically, accustomed to the outdoors and to roughing it, with good eyesight and a good "eye for country". Such men could be taught to be very fine plane-tablers and draftsmen but their lack of general education prevented their use as "surveyors" in the wide sense of the word.

Because this staff did not command high wages, the cost of plane-tabling was relatively low and consequently air survey methods had not been generally used in India, being more expensive than plane-tabling on all topographical map scales. To-day however, the shoe may be on the other foot ; improvement in aircraft and cameras has made air survey much cheaper than it was, while on the other hand increase in wages has greatly increased the cost of ground surveys which require many more individuals to be employed and of course the use of considerable quantities of transport, tents, etc.

Up to 1939, then, air survey had been little used in the Survey of India for topographical work, except in areas inaccessible on the ground such as Tribal Areas, or as training for military survey purposes. The air survey methods taught were, therefore, mainly parallel in scope to plane-tabling methods, the same personnel in general being utilized for both methods.

18. **Topographical instruments.**—Because of the personnel available for plane-tabling and the fact that travel using bullock-cart camel, labourer, etc., transport makes for rough treatment, the instruments used were the most robust and simplest it was possible to devise. Furthermore, such instruments could be manufactured in

the Mathematical Instrument Office of the Survey of India, at Calcutta. The plane-table was sturdy, heavy and 30"  $\times$  24" in area because this area could accommodate a full standard topographical map sheet while still leaving plenty of room round the margins for plotting of distant trig. points and for entering village names, inspection notes and the other information required by Departmental procedure.

The sight-rule was of the open type, 30" long ; telescopic alidades as used in many western countries were not used at all.

The clinometer, the "Indian Pattern Clinometer" invented and developed in India by the M.I.O., was also the open sight type, sturdy and readily adjustable in the field, with no lenses to fog up or grow fungus.

Despite these simple instruments, the standard of accuracy of a good plane-table was extremely high, even on out-turns of 25 to 30 square miles per month on the one-inch scale with surveyed contours at 50 feet vertical interval. General accuracy was maintained by the principle of working from the whole to the part and wherever possible basing work on graphic resections from topographical ( tertiary ) triangulation the latter in turn based on the main high precision triangulation of the Great Trigonometrical Survey. Where country was too flat to triangulate, theodolite traverse was used to control plane-tabling and air surveys.

Air survey instruments were correspondingly simple ; the only really complicated instrument in the possession of the Survey of India before the war was a stereocomparator, used mainly in the development of air survey from oblique photographs, necessary to make the best use of photos available on the North-west Frontier.

24"  $\times$  20" plane-tables of lighter construction, with 24" sight-rules, were mainly used for military surveys.

19. Theodolites and levels.—As with detail survey instruments, and for the same reasons, the theodolites and levels used by the topographical staff were of the simplest and most robust type obtainable, except those used for military survey purposes and by officers, 5" and 6" vernier instruments, mostly of the transit type, were in most general use.

For high precision work, and for use by officers and in military survey work, micrometer and glass-arc instruments were in use. The Department had a number of Wild, Tavistock and Zeiss glass-arc small theodolites and the Geodetic Branch used two larger Wild instruments for its high precision work.

Levels for tertiary work were simple Dumpy, "Y" and Cooke types, except for a few "split-bubble" small Zeiss instruments ; larger ones of this type being used for high precision levelling.

Personnel earmarked for military survey units were taught the use of glass-arc theodolites and split-bubble levels.

20. Fair-drawing.—The field plane-table section has rough treatment and is naturally drawn in different styles and with



different skills by the various plane-tablers. Reproductions of plane-table sections were therefore assembled in mosaics on paper suitable for re-drawing during the office ( "recess" ) season, these fair-drawings being sent to the publication office for the final stage of turning them into a published map.

Though some personnel were recruited solely as draftsmen, the great bulk of the fair-drawing was done by the field staff ( plane-tablers ) ; the draftsmen were mainly used for compiled mapping, that is, the compilation of a number of relatively large scale maps into one small scale one.

Field parties were therefore accumulated in the recess season at their Circle headquarters in the various parts of India. As with field instruments, the drawing instruments used were the simplest types possible, so far as possible those that could be manufactured in India by the M.I.O.

It was the duty of officers and specially selected surveyors and draftsmen in the field parties to examine the work of the men employed on fair-drawing to ensure that their work was accurate and that it conformed to the Departmental rules of standardization ; of the local drawing office to check again before despatching fair sheets to the publication office and finally of the main drawing offices at the publication offices to check yet again. This was a slow procedure and one that had to be drastically modified during the war with ( as might be expected ) a falling off in accuracy and standardization.

**21. Publication.**—The main map publication, storage and issue offices were at Calcutta, built up over the years since the Department was formed in 1823. A much smaller office, dealing with certain local and specially selected maps, was at Dehra Dūn as part of the Geodetic Branch. Publication plant was in use in Quetta and Risālpur/Murree but only for special jobs ; no standard maps were published at either place prior to the war. These two units however were trained particularly in producing something that would do in emergency, *quickly*, rather than in meticulous accuracy and meticulous adherence to Departmental procedure and rules.

As already stated, all but six of the printing machines in use by the Department in 1939 were flat-bed machines ; of the six hand-feed rotaries, four were earmarked for military use in case of war, the other two ( Calcutta ) not being readily transportable. Five modern high speed automatic feed machines, not transportable, were on order.

It was seldom that the number of copies printed of any one map exceeded 500 ; with such short "runs", very different to the 10,000 or so of the war, our somewhat antiquated flat-bed machines and hand-feed rotaries were adequate. Our bottle-neck was in colour separation, that is, preparing the different plates required for multi-colour printing. It was this latter fact that led to the reduction in number of map series and number of colours on individual maps, discussed briefly in the following chapter.

**22. Administrative organization.**—The Class I and Class II Services were gazetted services, the former consisting mainly of military officers recruited from the Corps of Royal Engineers and the Indian Army; the latter recruited from civilians of university graduate or corresponding educational standard. 5 vacancies were reserved in the Class I Service for promotion from Class II.

The Upper Subordinate Service, non-gazetted, was intermediary between the Class II and the Lower Subordinate Service, the latter containing the great bulk of our field and drawing personnel and together with its somewhat complicated counterpart, the Division III Service, the bulk of our clerical staff and map reproduction personnel. Division II personnel corresponded, on the clerical, drawing and map reproduction sides, to the Upper Subordinate Service.

There were other special posts for special duties, particularly in the Map Publication Office and the Geodetic Branch.

To co-relate these various services with military ranks when mobilized was a problem.

Finally, there was the Class IV Service—the completely uneducated men who carried instruments, pitched the camp of a surveyor and generally did the many errands necessary to the expeditious and efficient prosecution of survey work. This fine body of men, the “other ranks” of the war, also possessed no small technical skill as chain-men, heliotropers and the like and as ink mixers, zinc plate grainers and map sorters; a good number were promoted to superior service during the war, “uneducated” though they were.

**23.** Each field party, drawing and other office of the Department contained its quota, usually a fluctuating quota, of each of these services. The officer-in-charge was, except in “detachments”, a Class I officer; detachments were usually commanded by a Class II officer. Camps in the field, sections in recess were under the control of Class II or Upper Subordinate or Division II officers, sometimes under a very senior and experienced Lower Subordinate or Division III “officer” but the latter more usually carried out the actual work or instructed the less experienced of their own service.

**24. Geographical (regional) organization.**—The headquarters offices were located in Calcutta until late in 1940 when they moved to Delhi. The main Map Publication Office however remained in Calcutta until much later on and in fact a large publication office, including the Engraving Office, remained in Calcutta throughout the war and after. Geodetic work was centralized under the control of the Director, Geodetic Branch, at Dehra Dūn. Under his control too was the Cantonments Detachment charged with the execution of the military cantonments survey programme approved and paid for by the Defence Department in consultation with the Engineer-in-Chief. Other offices under his control were the Forest Map Office, a small map publication office known as the Photo-Zinco Office (P.Z.O.) as opposed to the much larger Photo-Litho Office (P.L.O.) under the Director, Map Publication in Calcutta, and

No. 2 Drawing Office specially skilled in dealing with exploration surveys and the counterpart of the main drawing office of the Department, No. 1 in Calcutta. The main Map Issue Office, the M.R.I.O., was in Calcutta, a small map issue section functioning in Dehra Dūn. A small Officers' Training School functioned sporadically under the control of the Director, Geodetic Branch; to be transferred during the war, much expanded, to Abbottābād under the control of the Director, Frontier Circle.

25. The creation and general organization of the Frontier Circle has been described in Chapter I. Its duties were primarily military until the financial stringency of the early thirties and again became predominantly, indeed almost entirely, military from late 1939.

A normal topographical Circle, of which there were four before the retrenchment of 1931 ( Burma, Eastern, Southern and Central ), consisted of the headquarters office of its director, a topographical drawing office and three topographical parties—a party being roughly the counterpart in survey of a Field Company, Sappers and Miners in engineering; its officer-in-charge ranked with a major unless actually holding higher military rank.

After 1931, only one orthodox topographical circle remained, the Eastern Circle with headquarters at Shillong and responsibilities covering Assam, Bengal, eastern U.P. and Central India and the northernmost part of Madras. Burma and South India were dealt with by "Independent Parties", considerably stronger than a normal party, under the direct control of the Surveyor General both technically and administratively. These two parties had headquarters at Maymyo and Bangalore respectively. Both practically disappeared during the war, but for widely different reasons. After the war, Burma re-established its survey organization on quite different lines and entirely independent of India while South India again was dealt with by a full Circle instead of a single party.

One topographical party ( No. 1 ) of the old Central Circle functioned in the central part of India under the orders of the Director, Geodetic Branch, while the Frontier Circle dealt topographically with north-west India.

26. Military organization.—There was no military survey service as such in India before the war; that is, there was no Geographical Section, General Staff as at the War Office in London and no survey units under military control, except for a small drawing office manned by personnel on the India Unattached List of the Indian Army; even this unit, though its work was directed by the General Staff, was administered by the Director, Frontier Circle who was also its technical adviser.

Army map policy was handled by the Director of Military Operations or ( later ) the Deputy Director of Military Intelligence at General Headquarters, as advised by the Director, Frontier Circle of the Survey of India. Mobilization map stores in Commands, Districts, etc., were controlled by the various Commands, etc., on policy laid down by A.H.Q., reserve stocks being held in the Map

Record and Issue Office of the Survey of India, at Calcutta. All military maps, except a few special items printed by the drawing office referred to above, were printed by the Survey of India.

All other military survey work was dealt with by the Frontier Circle ( paras 8 and 9 ) which also dealt direct with the R.A.F. for its map needs. There were few dealings with the Royal Indian Navy, who made their own charts where Admiralty Charts would not suffice.

27. The peace time organization of the Frontier Circle has been outlined. "A" and "E" Companies were intended to form the nuclei of the first units to be formed when mobilization was required; they were originally so-called to permit expansion up to eight companies, "A"—"H" and the title "company" was given to distinguish from the normal Departmental title of "party". When a possible eight companies was envisaged, the Survey of India was nearly twice as strong ( 1925 ) as it was in 1939, due to the 1931 retrenchment. In the event, the equivalent of not much less than ten companies was found in the 1939-45 war, though our commitment immediately preceding the war was only two headquarters and two companies for service on the N.W. Frontier, plus the Survey Depot.

The comparative strength of the Department in 1939, 1941, 1943 and 1945 is given in Table C at the end of this book; "Topographical Assistants", of which there were 97 at the end of the war, were a new departure described under that heading in the Index portion of the book. Perhaps the greatest single factor affecting military organization was that whereas there were nearly 60 military officers in 1925, there were only 30 in 1939; to train a civilian to be a sound and efficient soldier takes a considerable time; to train a non-survey soldier to become an efficient surveyor, much longer, very much longer.

## CHAPTER III

### INTRODUCTORY—( *concluded* )

**28. Map scales.**—The topographical map series of the Survey of India were on “inch scales”, that is one mile to an inch, two miles to an inch and four miles to an inch. These are generally and conveniently referred to as *One-inch*, *Half-inch* and *Quarter-inch* maps ( or *1-inch*,  $\frac{1}{2}$ -*inch* and  $\frac{1}{4}$ -*inch* ).

Some atlas type small scale maps, such as the general map of India on scale 1 inch = 160 miles, are generally called the *160 mile* map of India and so on.

The cantonments and bazar series are generally on 16-inch and 64-inch scales respectively and some town guide maps are on inch scales.

**29.** The majority of geographical maps are on natural scales, 1/1,000,000 and 1/2,000,000 and these are conveniently referred to as *1/M* and *1/2 M*. A new map introduced during the war was the 1/500,000, sometimes referred to as the *2/M*.

The majority of town guide maps are on the scale 1/25,000 which is also the scale very frequently used for military tactical maps; this scale is usually referred to in full, *1/25,000*.

**30. Map series and coverage.**—Until shortly before the war there were three topographical and three geographical maps series in general use :—

The *1-inch*, laid out in quarter-degree “squares”, covering the more densely populated parts of India and Burma and some areas of military importance.

The  $\frac{1}{2}$ -*inch*, laid out in half-degree “squares”, covering areas also covered by the 1-inch and in addition, areas not worthy of the expenditure necessary for 1-inch surveys. There were also some  $\frac{1}{2}$ -inch maps of parts of Irān that had been occupied during the 1914–18 war.

The  $\frac{1}{4}$ -*inch*, laid out in degree “squares” and hence often called *Degree Sheets*, covering the whole of India and Burma, Afghānistān, Irān and most of ‘Irāq.

The *1/M India and Adjacent Countries ( I & A C )*, laid out in four-degree “squares” covering the same areas as the  $\frac{1}{4}$ -inch series, plus a considerable extension north and east to latitude 40 degrees and longitude 104 degrees.

The *1/M International ( Carte Internationale du Monde )*, laid out in six-by-four-degree “squares” still in process of completion and intended eventually to supersede the older I & A C series. The



former series was designed internationally and, in India, had an auxiliary air edition mainly used by the R.A.F. on which relevant aeronautical information was over-printed.

The *1/2M Southern Asia*, laid out in twelve-by-eight-degree "squares" covering an area almost as extensive as the *1/M*.

31. Besides these standard series, there were various general, provincial, etc. maps on small scales as well as town guide maps, cantonment and similar maps, and on the N.W. Frontier a small series on 1/25,000 scale bounded, however, by *grid* lines instead of by lines of latitude and longitude like all the series mentioned in para 30.

32. **Grid and Mesh.**—Some system of reference for accurately defining the position of a point on the map is necessary for military purposes. During the 1914–18 war sets of arbitrary squares gave way to *grids* which are orderly systems of squares, each system emanating from a specific point on the ground, that can be applied identically to maps of a single area, on whatever scale, or to whole series of maps. If field survey work is carried out in terms of the grid projection, survey co-ordinates are identical with map co ordinates and for this reason all military survey work in India was carried out in terms of the Lambert conical orthomorphic projection, that used for the gridding of Indian maps. That Indian topographical maps were published on a polyconic projection is immaterial. Civil surveys, however, had normally been carried out in geographical terms (latitude and longitude) and consequently the co-ordinates of surveyed points had to be converted into Lambert grid terms for military purposes, a heavy computational job; this applied also to many other areas with which we were involved during the war in order to produce "Grid Data Pamphlets" such as had been prepared before the war of considerable areas of India itself.

33. Grids are not applicable with accuracy to large *areas* though they can be applied very accurately to long strips. For this reason, Indian maps were originally covered with a reference system of lines of latitude and longitude, accurate anywhere, known as the "Minute Mesh". Though this was superseded by the Lambert Grid long before the war, some meshed maps will have found their way to map users in some areas (and some that were neither gridded nor meshed) because these were on the store shelves and in the early stages of the war anything that could be found of war areas had to be utilized.

Not all maps were gridded (or meshed) but only those of selected areas of military importance, because civil authorities in general preferred "clean" maps; much gridding had, therefore, to be done during the war.

34. The system of letters and numbers used to identify grid lines on the maps of India and neighbouring areas for which India was responsible was like that known as the British Modified System, which, however, gave way to the "Canadian System" on many maps during the war, because of greater convenience (at the expense of some lack of clarity of map detail) in reading a folded map (See Plate IV).

Letters and numbers could be printed in any colour as indeed could the grid lines ; the lines themselves, however, were normally printed in black on Indian maps, being an inherent part of the black detail drawing and hence precisely accurate in relation to black detail including "trigs" but not so in relation to other colours except in maps of perfect "registration", a perfection not easily attained.

35. Colours on maps.—Normal Indian topographical practice had been ( roughly ) brown for relief, red for man-made features except railways and canals, blue for perennial streams, canals and water-filled areas, green for afforestation, yellow for cultivation and black for all else, including the bounding lines of some of the features mentioned.

Geographical map practice varied from the foregoing somewhat, the International series following the rules agreed upon internationally ; and military maps on 1/25,000 scale were usually in black and brown only.

All the above colours plus the inclusion of various ribands to draw attention to boundaries ( a different colour for each Province ) resulted in a large number of printings being required for each map, and much delay in colour separation work. Hill shading was also sometimes employed, resulting in yet another printing. On geographical maps, layers were used to indicate relief in one edition, another edition being published ( for political use ) without layers.

36. Apart from slowness in publishing the results of new surveys, all these printings and their attendant colour separation problems had made the *revision* of existing maps a very serious problem ; in fast growing areas, even a revised map was out-of-date before it was in the hands of the public.

It was therefore decided, shortly before the war, to dispense with two map series ( para 30 ), the 1/M I & A C being superseded by the International series and the ½-inch series being discontinued except where it *replaced* the 1-inch as a tactical or civil administration map.

It was also decided, at least as an interim measure, to publish most of the topographical maps in black and brown only ( or in some coastal, etc., areas in black, brown and blue ) pending catching up on revised maps ; meantime investigating the possibility of re-designing the maps to dispense with red altogether for man-made features ( para 35 ). In most cases, this policy was easily put into effect because there existed for almost all topographical maps a "combined original" or negative which incorporated all detail except brown. On the other hand, maps were designed for multiple colours and the black and brown result was, therefore, not nearly so legible as it would be if maps were specially designed for it, as in Britain and elsewhere.

37. By 1939, the new policy was taking effect and map production had speeded up considerably ; concentration on compiled mapping ( para 10 ) also speeded up ¼-inch map issues.

The army did not like the black and brown policy very much but nevertheless preferred up-to-date maps and more of them, at least for the moment. Being organized for this new policy, many more maps were produced during the earliest stages of the war than would have been possible on the old multi-colour system.

**38. Map issues.**—Map storage and issue in the Department was so organized as to deal expeditiously with a multitude of small demands for many different map sheets, the majority of issues being by post or over the counter ; we were not organized for large bulk issues either in respect of storage or packing and despatching facilities, which had to be developed after the war started.

The great majority of maps were stored in and issued from the Map Record and Issue Office in Calcutta, Dehra Dūn's small issue section dealing mainly with local demands and of course the various parties held a few copies of maps covering their areas.

The army took over their maps at their various depots and were responsible for their own storage and issues.

Though the magnitude of the storage and issue problem in war had been recognized, no practical tests had been carried out, mainly due to lack of funds.

Paper storage too became a big problem ; a rotary offset machine working at moderate speed ( 4,000 per hour ) will eat up a ton of paper in a few hours. Only 7,500 copies of an average map, quite a normal run in the war, will weigh about  $\frac{1}{4}$  ton.

**39.** Except for maps used by the Department itself and a few complimentary copies issued to local officials, etc., all maps were issued on payment. The military services however, received a 50% discount on maps purchased from stock but for special orders paid the actual cost of drawing and publication plus 5%, postage extra.

This procedure was necessary to facilitate departmental budgetting and to keep map demands under control. To have made free issues to government officials would have put the Survey of India in the position of dictating how many maps any particular department might have, which would have depended entirely on the Survey of India budget allotment at the time.

## CHAPTER IV

### THE WAR AND RECONSTRUCTION IN OUTLINE

40. 1939-1942.—The situation on the outbreak of war has been outlined in the preceding three chapters ; the present chapter, which describes very briefly the salient happenings of the war and earliest reconstruction periods, is intended to assist the reader in following the succeeding more detailed chapters.

From 1939 to 1942 movement was mainly westwards ; in 1943 the position had stabilized and eastward movement began, the demand for more and more maps and personnel and for more and more reconstruction projects following in its train.

41. At its outset, the impact of the war was not seriously felt in India. So far as the Survey of India was concerned, curtailment of civil programme, more comprehensive and intensive military training, improvement of war establishments and equipment tables and mobilization schemes and a general check-up on our map situation coupled with expediting the five new rotary offset machines on order were the immediate results. The Mathematical Instrument Office expedited supply of mobilization instruments required by the Department and began to manufacture certain instruments required by the army ; it was transferred to the Department of Supply in 1941.

42. A conference in Cairo ( Mid-east ) early in 1940 and another in Delhi between Malaya, India and Mid-east early in 1941 crystallized policy and commitments and resulted in arrangements whereby any one of the three survey services could assist or take over the map publication of the others in the event of destruction by enemy action. Survey of India commitments for military survey units were greatly increased and our first units were formed in 1940, to proceed to 'Irāq early in 1941 by which time others were under formation for 'Irāq and followed in early autumn. Four officers of the Survey of Malaya were trained in Indian military survey methods in 1941.

Maps supplied during this early stage were predominantly of 'Irāq, Irān and north-west India. The major publication task was bringing these maps up-to-date as far as information went, and gridding many of them.

43. The Burma Survey Party, reinforced by personnel from India, did a considerable amount of revision work on lines of communication both by ground and air methods ; a civil assistant directorate was created in 1941 and special war establishments and equipment tables put in hand, a military assistant directorate and a field survey company ( No. 6 ) being formed early in 1942 from personnel in Burma.

When Burma was evacuated, the military and civil units marched together to India via the Chindwin to Rāmpur ( Assam ) ; the civil unit was disbanded but for a small nucleus headquarters to settle accounts and watch the interests of individuals in respect of compensation, etc., and the military units joined Eastern Army for reforming and re-equipping. A number of Burmese members of the party remained in Burma along with some Indian members who had made their homes there.

About  $\frac{1}{2}$  million maps were poured into Burma from the publication offices in Calcutta by land, sea and air ; lack of distribution facilities prevented the majority from reaching the troops till a Map Supply Section was sent from India ( to be captured by the Japanese later ) and a local civilian section formed there by the A. D. Survey.

Burma survey records were nearly all lost but for the original fair drawings, from which most of the maps used in the re-invasion of Burma were subsequently prepared.

44. 1942-1943.—The great increase in commitments from 1942 onwards, when the Survey of India became the Base Organization for the South East Asia theatre, made necessary the creation of a Geographical Section, General Staff headed by a Director of Survey, India who was responsible to the C.G.S. for military survey and map policy ; this officer was also a Director, Survey of India in charge of the newly formed Military Circle which included the Survey Stores Office of the Survey of India and the Department's organization for supplying and administering personnel required by the army. From then on, the Survey of India as such had no direct responsibility to the army, its responsibility being through the Director of Survey ( India ) on one side and the Government of India on the other. The Frontier Circle, previously directly responsible for all military activity, then became mainly a training organization while at the same time being responsible for maps required by Northern Command ( North-West Army ) only.

45. The five rotary offset printing machines that had been ordered before the war greatly increased map publication power, still further increased before the end of 1943 by additional machines and ancillary equipment obtained through military channels ; map output was increased more than 25 times between 1939 and 1943 ( from  $\frac{3}{4}$  million in 1939 to 20 million in 1943 ) which necessitated the creation of a special attached cadre of officers and other ranks of the Corps of Royal Engineers, there being little trained lithographic and map publication manpower in India outside the Survey of India. This personnel was distributed between the Calcutta offices, the greatly expanded publication office of the Geodetic Branch and a new "map factory" designed to accommodate eight to ten modern printing machines that was established at Hāthibarkala, Dehra Dūn, about three miles from the Geodetic Branch offices.

Officers from this cadre were also employed in charge of the rapidly expanding Stores Office ; though this office dealt with all

survey stores, the vast majority were stores pertaining to map publication.

46. During this period ( up to the middle of 1943 ) the strength of the Survey of India ( excluding Class IV servants and attached cadres ) rose from 1400 all ranks to 2260 all ranks, of whom 620 were in military survey employ in the Geographical Section, General Staff, the Central Map Depot ( Delhi ), five Survey Directorates of different types, seven field and air survey companies, four map supply sections and two survey park sections.

Military units sent to 'Irāq earlier had by this time nearly all returned to India for regrouping and refitting before moving eastwards and the Survey of India had itself regrouped considerably, the Eastern Circle having been transferred *en bloc* from Shillong to Dehra Dūn, joined by most of the South India Party, to concentrate map drawing power ; and the headquarters of the Department now functioning in Delhi instead of Calcutta, with Map Publication headquarters just about to move from Calcutta to Dehra Dūn into the new Hāthibarkala factory there.

47. Geodetic and similar scientific work was light at the outset of the war and steadily decreased till about 1943 when there was a great up-surge due to preparations for forward movement east and concurrent heavy computations in connection with 'Irāq triangulation ; on the other hand, the drawing, map publication and large scale field work of the Geodetic Branch vastly increased in the earlier stages, as did its administration. In 1943, the Branch was split by the formation of a War Survey Research Institute to deal wholly with scientific work, leaving the Geodetic Branch itself to deal with the remainder of the work, increasingly map publication and special surveys ( Cantonments Party ) of airfields, military camps, arsenals, depots, etc.

Other field survey work in the Department, except that connected with military training, practically ceased, the only major field survey works by 1942-43 being those carried out by No. 12 Party of the Eastern Circle in the Ledo Base area in Assam and by a special Perso-Baloch party, in co-operation with No. 3 Indian Field Survey Company, in south-east Persia ( Irān ) and Baluchistān, which involved triangulation and revision of road communications into India.

48. 1943-1946.—Regrouping of military units had been completed by early 1944 and with the appointment of a Director of Survey in the South-East Asia Command the control of a large proportion of these units was passed to him, demands on the Survey of India for maps, personnel and stores, however, being filtered as regards priority by the Director of Survey ( India ). The problem of the Department was thereafter quantity versus time.

49. As it became apparent that the Allies had achieved supremacy over the Japanese, so other problems for the Survey of India appeared—post-war reconstruction and the peace employment of



the two million or so men in the Indian army began to engage considerable attention and the numerous schemes to these ends made it difficult to concentrate on purely war problems. Coupled with this was the demand for surveys in connection with "Grow More Food" projects, necessitated by the loss of Burma rice and the huge influx of troops into India, who had to be fed.

Early in 1944 it was found necessary to set up a Projects Office that at the outset registered and examined reconstruction and grow-more-food demands, then began to execute them and finally while executing the smaller demands examined and organized the larger ones, passing the actual execution of the latter on to the appropriate circle or party of the Department ; by 1945 many small surveys were in progress, mainly by air methods, and many larger ones in the organizational or even training ( in special methods ) stages. So many men still being in military employ even in late 1945 and 1946, it was necessary to devise every expedient that we could to save time and manpower.

Work in the War Research Institute was very heavy in 1944-45 in connection with tides, computations, grid data, trig dossiers, magnetic charts and research in astronomical observation methods, switching in 1945-46 to development of the "AID" survey framework for India ( para 161 ) and research in methods to expedite and cheapen reconstruction projects, the name of the Institute being altered to "Survey Research Institute" on the cessation of hostilities.

50. Map publication and stores organizations had of course also greatly expanded, even by comparison with 1943. The question arose what to do with surplus plant, personnel and stores, when the war ended. To scrap publication plant or even to put it on a "care and maintenance" basis must result in the dissipation of large numbers of personnel trained during the war at great expense ; on the other hand, to keep the plant and personnel against any future emergency implied finding useful work for it in the meantime. A number of proposals were put forward but no decision had been reached by 1946. Surplus stores were beginning to be disposed of by this time, though much still remained to be done to clear the huge quantity accumulated for the eastward advance.

51. From 1943 onwards the post-war organization of the Survey of India, and the creation of a permanent military survey service, received an increasing amount of attention ; plans decided in principle in 1945 were beginning to be effected in 1946. Though many officers and other ranks were still in military service in 1946, many had also been demobilized and were beginning to fit into the reorganized Department.

The war ended with 721 officers and other ranks of the Survey of India in the army ; and with the total strength of the Department ( including those in military employ but exclusive of Class IV servants both in civil and military employ ) reached the total of 2,957, a little over double the pre-war strength.

The post-war sanctioned strength of the Department ( 1946 ) was seven circles and twenty-four parties as against four circles and twelve parties in 1939.

52. Chapter XII contains a brief comparison between 1938-39 and 1945-46 and some statistics and budget data. Details are contained in the various tables at the end of the book.

## CHAPTER V

### WAR, 1939-1940

53. September, 1939.—It had become increasingly clear that war was coming but when, and exactly how it would affect India at the outset, was not so clear. So far as the Survey of India was concerned, little active preparation for war had been undertaken except for the military exercises already referred to, the curtailment of field programmes, the revision of war establishments and war equipment tables (based on N.W. Frontier warfare) and the speeding up of the preparation of mobilization schemes and the checking of our role as laid down in the "War Book, India". The recall of officers on leave in U.K. (para 13) anticipated the actual start of the war by some days and these officers reached India in the last part of September, being distributed as best calculated to serve military needs that might develop. Officers on leave in India were recalled as soon as war was declared.

54. The first steps required after 3rd September appeared to be to ascertain what was immediately required of us (apart from warning orders to all volunteers for military service to stand by) and to make sure that the terms of service promulgated in 1934 (para 9) would hold good. A visit to "A" Branch, Army Headquarters on 4th September made it clear that they would *not* hold good because they were based on "general mobilization" and general mobilization (whatever that term may mean) was not then envisaged; this was a shock—all our volunteer lists were based on these terms; a suggestion that the word "general" be deleted from their heading was of no avail and we had to start afresh both in the preparation of terms of service and in the *re*-calling for volunteers on *no* terms of service. Naturally, volunteers were hesitant; one likes to know what one volunteers for. No one could be *ordered* to military duty except our Class I officers of the Royal Engineers and Indian Army (about 30 all told) and approximately the same number of soldier surveyors who were on the Indian Unattached List or the newly formed Reserve of Military Surveyors.

We were, however, fortunate in having no civilian officers on any military reserve as in 1914 (para 5) and that it was recognized by the Defence Department that survey would play a considerable part in the new war and survey skill must not be dissipated as was done in 1914. We were also fortunate in that war occurred while the Government of India and Army Headquarters were still in summer quarters in Simla, as was the Surveyor General; as Director, Frontier Circle responsible for military organization, my own office was located permanently in Simla and my Frontier Circle units

had not yet taken the field and were themselves in immediate touch with Northern Command at Murree ( "A" Company and 18 Party ) and Western District, the successor of Western Command, at Karāchi ( "E" Company ). 18 ( Air Survey ) Party was also in close touch with the main Frontier air station at Risālpur and I was in close touch with Air Headquarters at Simla. The Department as a whole, though preparing for a limited field season, had still not left summer headquarters. Things might have been much worse and so far as the Department was concerned, Hitler made a mistake.

55. Field Season, 1939-40.—The Government of India and Army Headquarters moved to New Delhi as usual in October and this year for the first time the Surveyor General ( Lewis ) also remained in Delhi, a part of his office coming up from Calcutta, later followed by the whole office from there, and Calcutta was finally abandoned as the Headquarters of the Department; the Map Publication Office, however, remained in Calcutta ( Slater ).

Of the Frontier Circle units, "A" and "E" Companies usually established field headquarters somewhere in the area of their season's work and 18 Party moved down from Murree to Risālpur about the same time as Northern Command moved from Murree to Rāwalpindi; this procedure was again followed, "E" Company ( Thackwell ) remaining in Karāchi, however, which was convenient as its work, revising  $\frac{1}{4}$ -inch sheets not far from there at the request of Western District, could best be done in close touch with the military, Public Works, etc., authorities concerned. "A" Company ( Angwin ) was working on verification surveys in the Punjab and made its headquarters at Lahore where the Lahore Detachment also was. 18 Party ( Crone ) had to occupy hired buildings in Risālpur as in the past, our own new offices not yet being completed; this unit was busy organizing the military training exercise, to be carried out near Risālpur under Crone's command.

The Director, Frontier Circle had been accustomed to spend most of the winter on tour, returning to Simla for accounts and office work at month ends; this year, I established a full tour office at Lahore so as to be in reasonably convenient reach of Delhi, Risālpur and Karāchi at all times, as well as Simla though I visited that place only once during the field season. The Surveyor General also held a big conference on map policy in Lahore, as being more convenient than Delhi, where accommodation was already becoming tight.

56. The only other units to undertake a full field season were No. 6 Party ( I. H. R. Wilson ) in southern India not far from Bombay, to catch up on the much delayed 1905 programme there; the Burma Party ( Wright ) which continued a normal topographical programme; and No. 20 Cantonments Detachment ( Ansari ), engaged on a long term programme for the Defence Department and Engineer-in-Chief.

Miscellaneous small surveys were undertaken, mainly for military or political purposes, and No. 18 Party continued its air programme on the N.W. Frontier ( Tribal Areas ). The rest of the effort of the Department was concentrated on improving the existing  $\frac{1}{4}$ -inch maps and preparing to meet war demands upon us, including the overhaul of maps of 'Irāq so far as we were responsible for them and of western Irān. ( We were responsible as far west as  $48^{\circ}$  E. longitude ).

As many military officers as possible were collected together at Risālpur for the military training carried out there in November-December.

57. This training followed the pattern hitherto of teaching rapid triangulation methods with a moving column, a tactical map being prepared in advance of the column's movement with corrected editions as more accurate trig. control became available and finally a "battle map" on 1/25,000 scale off which the Gunners could do predicted shooting with accuracy ; all maps being prepared from air photographs and controlled by the rapid triangulation carried out during the exercise. This is the main problem that would have faced survey units in pre-1939 conditions in unsurveyed country, which is what was envisaged for the employment of units formed from the Survey of India. Mistakes made in this exercise and the need for training yet more personnel in this task led to a number of weeks' intensive training in triangulation methods early in 1940 and the formulation of more or less standard procedures for meeting certain sets of conditions likely to be found in country such as beyond the North-west Frontier of India. The procedures formulated are described in the Survey Service Pocket Book ( India ) Part XI.

In the event, this procedure was seldom used during the war but the triangulation training stood the survey service in very good stead, particularly in 'Irāq and Irān, in the early part of the war.

58. Cairo Conference, March 1940.—In the latter part of March I accompanied the D.D.M.I., India ( Colonel, now General Sir Ouvry, Roberts ) to Cairo to attend a military intelligence conference at Mid-east headquarters at which War Office representatives were also present, and to discuss and co-ordinate map and survey policy with the Director of Survey, Mid-east ( Colonel R. L. Brown ). We were required to wear civilian clothes travelling from India and owing to baggage limitations were permitted to wear them in Cairo except for the most formal conferences ; when he happened to look in his Operation Room one day, the Commander-in-Chief in Mid-east was a little surprised to find two civilians poring over his maps.

Many survey and mapping details were discussed with Mid-east Survey Headquarters and the conference decided on the map series to be established in 'Irāq on scale 1/250,000, 1/50,000 and 1/25,000 and, after some debate, that these maps should be bounded by grid and not spherical lines ; this was standard practice for certain series

in Britain and also in India ( para 31 ) and though the system has disadvantages, it has the great advantage that the title of the map ( based on scale and the co-ordinates of its south-west corner ) places it in the grid straight away ; on the other hand, it does not place it so easily geographically.

It was also agreed, subject to the approval of the Surveyor General and the Government of India, that the Survey of India would be responsible for providing up to seven headquarters, six companies, three survey park sections and two map supply sections for service anywhere required ; this was a considerable step-up on our previous commitment of two headquarters and two companies for service on the N.W. Frontier of India, and necessitated still further recasting of our volunteer lists.

59. The grid decided for 'Irāq was, as used in India, the Lambert conical orthomorphic with which our personnel were of course thoroughly familiar. There were geodetic problems however, for surveys made in 'Irāq during the 1914-18 war were based on the Everest spheroid, itself based on Fāo ( Shatt al Arab ) while subsequent surveys by the 'Irāq survey department were based on the Clarke 1880 spheroid, itself based on Nahrwān, near Baghdād.

This led to a meeting in Baghdād between representatives of Mid-east and India with the Director of Survey of 'Irāq ( Mr. A. J. Booth, previously of the Survey of India ) and to the despatch from India in June 1940 of a small computing detachment to carry out reconciliation and adjustment ; this detachment remained in 'Irāq till early in 1941, after which considerable further adjustment was done in the Geodetic Branch.

60. Summer, 1940.—The despatch of a computing detachment to 'Irāq, a civilian detachment not mobilized, has been mentioned in the preceding paragraph.

The despatch of Indian troops to 'Irāq and Irān to safeguard the oil refineries at Abadān meant demands for maps of that area and much of the map drawing and publication work during 1940 was in meeting these demands ; it has been mentioned earlier that the army was normally charged drawing and publication costs, plus 5%, for special jobs and this system was applied now, with a simplified formula for drawing charges—map publication charges had for long been systematised but higher costs in recent years offset by more modern methods and machinery had made the accuracy of our rates very doubtful and revision was under consideration. It was hard to find time to carry out this revision and with the flat-rate system introduced the following year, it was postponed till after the war ( para 81 ).

Shortly before the war, responsibility for maps of 'Irāq and Irān west of longitude 48° E. had been transferred to the War Office, London together with most of our records of this area much of which was surveyed by Indian survey units during the 1914-18 war ; during 1940, the War Office sent us copies of our records.

sufficient to permit publication of maps in India again while at the same time permitting publication in Britain as well. Troops could thus be supplied either in India or Britain, whichever they emanated from, with more or less identical maps though the latter point of ensuring real indenticality presented a problem that was to receive more attention later on as more and more map publication offices in various parts of the world entered the eastern map publication field.

Drawing and to some extent publication of maps was farmed among the offices of the Department to make the most use of all resources ; distance however made control difficult, particularly in respect of drawing.

61. The new large commitments accepted by India for the formation of military survey units ( para 58 ) and the decision to mobilize some units practically at once, besides forming a military Survey Depot ( Risālpur ) and soon after it a civil counterpart euphemistically called a Survey Training Centre, began to make the Frontier Circle somewhat unwieldy for a single individual to control. Early in the year, therefore, an Assistant Director ( Civil ) was allotted to the D.F.C. followed soon after by an Assistant Director ( Military ). In effect, the Circle at this time divided into two wings, military and civil. Headquarters continued to be at Simla, where also were the S.G., A.H.Q. and the Government of India ( summer headquarters ).

At one time, there were several A.D.F.C's ( Military ) either officially or *ex officio* and this perhaps was good for it led to a number of senior officers, later to take over various military survey headquarters and the like, being in a position to wrangle about the best way of meeting our problems. This resulted in smooth working in the end.

62. Mobilization of our first units commenced in July and August 1940, the first officer to revert temporarily to military employ for service ex-India being Colonel W. J. Norman, M.C., on 14th July. Colonel Norman, who had a great deal of experience of military survey and was an expert air surveyor, died at Dehra Dūn before actually taking his headquarters and units overseas ; this sad loss was keenly felt by the Department and by the military survey service.

The mobilization of No. 1 Indian Field Survey H.Q. and No. 1 Indian Field Survey Company was carried out at Risālpur, where the new offices were now practically complete. Mobilization stores, previously in the charge of "A" Company, were taken over by No. 18 Party so as to leave "A" Company more free to perform its allotted role of nucleus for No. 1 H.Q. and No. 1 Company and, assisted by the newly formed Survey Depot, to implement their mobilization. Proximity to Rāwalpindi arsenal assisted in the quick supply of instruments and equipment to be obtained from military sources, while articles of Survey of India supply comprising the majority of instruments, technical books and stationery, etc.,



were either already in store at Risālpur or were quickly obtainable from the Mathematical Instrument Office or Geodetic Branch, except for some articles in short supply like nautical almanacs, and glass are theodolites. Though rotary printing machines were available ( para 15 ) we had great trouble in acquiring suitable motor transport on which to mount them. Before No. 1 Company left India, however, a machine had been established on a trailer for it.

63. The large expansion in commitments for military survey units made it necessary for us to tap all possible sources for officers and other ranks with previous survey or map publication experience and, to free more junior officers for military duties, to extend the service of more senior officers and re-employ as many as were willing and suitable for jobs in the Department itself, including a number of newly created posts. This policy was of necessity followed throughout the war and early reconstruction.

Also to conserve survey trained personnel, non-survey officers and other ranks were utilized in the field units in posts such as Adjutant and Quartermaster, Quartermaster Havildar ; these were obtained through army sources and placed on the strength of the Survey Depot at the outset, not being attached to the Survey of India as were technical officers under training. The Adjutant of the Survey Depot was also a non-Survey officer who eventually took over command of the Depot ( Major Gidman ).

During the summer of 1940 there was a considerably higher than usual intake of officers and surveyors for air survey training in No. 18 Party, and some refresher courses.

64. A good deal of work was done on the preparation of new war establishments and war equipment tables ( the counterpart of the British "G 1098" ) as a result of the military exercise of 1939 and alterations in the scope of military commitments in the light of the Cairo conference and experience in Mid-east up to the middle of 1940. The equipment tables in particular were a heavy task.

To reduce office work as much as possible, a number of pre-war reports and returns both administrative and technical were suspended and the regular annual General Report of the Survey of India was cut approximately in half in letterpress matter and all but 100% in charts and illustrations. The introduction of war diaries was considered but decided against as introducing as much extra work as was saved by the cuts mentioned. Special "War activities" Reports were, however, initiated in 1941 and from 1942 the D. Svy. ( India ) issued a report on the working of the military Survey Service.

At this time the question of putting all military officers of the Department into uniform was raised by me and decided against by the Surveyor General ( Lewis ) ; the question arose again later on and was again decided against by me as Surveyor General for reasons given in para 83.

65. **Burma.**—There were no important changes in survey and map policy in Burma till late in 1940. The O.C. Burma Survey Party (Wright) visited Malaya and Netherlands East Indies to familiarize himself with the map and survey situations in those countries and also reconnoitred the line of approach from Siam to Moulmein in Burma.

Burma mapping records had been transferred from the M.R.I.O. in Calcutta to Burma, following the separation of that country from India in 1937. Maps, however, continued to be published in the Map Publication Office in Calcutta, records for the purpose being sent from Burma as required and returned with the published maps.

66. **Afghānistān.**—A special survey of coal bearing areas north of Kābul was in progress during the summer of 1940, undertaken at the request of the Afghān Government through the Geological Survey of India ; the detachment involved was small, and this work was continued to completion in 1941, resulting in some useful maps and triangulation.

A special set of our quarter-inch maps of Afghānistān ( about 90 sheets in all ) was also under preparation for the Government of Afghānistān and delivery was now nearing completion.

## CHAPTER VI

### WAR, 1940-1941

67. Field Season, 1940-41.—Except in Burma and south-west India ( para 56 ) there was no routine field season, only some 2,400 sq. miles being surveyed on the 1905 programme compared with 20,200 in 1938-39 and an average of 36,000 in the preceding three years. 3,200 sq. miles of revision was done however, mainly to meet military requirements in north-west areas, and some special surveys for war purposes were carried out.

In Burma, nearly 5,000 sq. miles of new survey was undertaken, more than the average of the past five seasons and double that of 1938-39 ; in addition nearly 6,000 sq. miles of verification survey was done as well as some revision ; this work ranged over a good part of central Burma and was aimed at improving general map cover.

68. Military survey training was carried out in the Burma Survey Party ( B.S.P. ) during the early weeks of 1941 ; this was the first military training undertaken by the Department except on the N.W. Frontier of India. War establishments and war equipment tables suited to the particular terrain of Burma were put in hand, the main problem being to evolve a unit that could work equally well with M.T., mule transport or labourers.

Two Burmese officers of status corresponding to our Upper Subordinate service had just completed a year's training in Dehra Dūn and joined the B.S.P. for further training. The B.S.P. itself contained a number of Burmese surveyors and draftsmen but the bulk of its personnel came from India and all its officers except for one Upper Subordinate ; some Indians, however, had made their homes in Burma.

Administrative problems were also receiving attention, particularly how to organize decentralization in the event of communications with Burma being cut off. There being no map publication power in Burma under the control of the Survey of India ( para 65 ), this point too had to be considered.

69. In India, war establishments and war equipment tables had reached "finality" and were promulgated early in 1941 ; these were fundamentally designed on the basis of small semi-independent *sub-units* rather than, as usual in military practice, on units. The purpose of this departure from standard procedure was to retain some of the flexibility inherent in the Survey of India non-rigid party system making for more economical use of strictly limited numbers of skilled personnel.

A Survey Service Pocket Book, designed on the lines of the military Field Service Pocket Book, was also put in hand to replace the old Field Service Manual of 1916 ; the various parts of this book were written by various officers of the Department, publication dead-line being set for March 31st, 1941. The book contained information of use to civilians unfamiliar with military methods in regard to signals, orders, appreciations and the like and in addition was an unofficial compendium of technical information and facts hitherto scattered among a number of miscellaneous publications.

70. Late in 1940, the Eastern Circle moved *en bloc* to hired offices in Dehra Dūn, its offices in Shillong being loaned to the army for a hospital ; the bulk of the South India Party joined this circle leaving only a small detachment in Bangalore. The time and space problem had been troublesome in controlling drawing power for war purposes, best concentrated for efficiency, and the expansion of the publication office in Geodetic Branch ( P.Z.O. ) in Dehra Dūn made it logical to increase drawing power there.

Nos. 4 and 12 Parties of the Eastern Circle were at this time combined, to save one senior officer ; "A" and "E" Companies of the Frontier Circle were similarly combined and redesignated "A/E" *Party* now that a military depot and several military units were in existence.

The Surveyor General's Office was by now fully established in Delhi and the Director, Frontier Circle had his main military office there, though F.C. headquarters still officially remained at Simla under the charge of the A.D.F.C. ( Civil ).

These various reorganizations coupled with extra recruitment and training and the paper work attached to the formation of military units greatly increased administrative work and necessitated the creation of extra administrative posts like Additional Assistant Surveyor General and an Assistant Director to look after the work of the Frontier Circle proper, at Murree and Risālpur. Karāchi and Quetta were abandoned as Frontier Circle stations.

Much increased drawing necessitated extra Chief Draftsmen's posts also, and eventually Assistant Director's posts in the Eastern and Publication Circles.

71. No. 1 Field Survey Company and Headquarters were ready to move overseas before the end of 1940 ; they were not immediately required—rather, transport was not available to send them overseas—and opportunity was therefore taken to carry out some 1/50,000 and 1/25,000 tactical map work urgently asked for by Western District on the approaches from Afghānistān, west of Quetta. The units were employed there most of the winter and were well "shaken down" by the time they proceeded to 'Irāq early in 1941.

By this time, Nos. 4 and 2 Companies and Headquarters were under formation at Risālpur and Dehra Dūn respectively, their stores and equipment being provided from the appropriate military

arsenals and R.I.A.S.C. depots and, in respect of instruments and stores of "Survey of India Supply", from the Mathematical Instrument Office in Calcutta and (chemicals, inks and technical stationery) the Map Publication Office and Geodetic Branch. Rotary printing machines for these units were available, but no tractor-trailers with which to haul them ( para 15 ).

72. The formation of Nos. 2 and 4 Field Survey Companies ( para 71 ) denuded us of a number of trained surveyors and heavy army recruitment, overlapping our recruitment areas for surveyors, made it clear that we could never provide the remaining units that we had promised unless we relied on army sources for man-power ; the principle was therefore adopted that for the period of the war there would be practically no recruitment of civilian surveyors, recruitment being *via* the army instead of as in the past mainly direct from civil sources with only a few soldiers taken in after completing the military survey course at Roorkee. Army Regulations, India, were suitably modified to permit the larger entry of soldiers into the Department while at the same time suspending the Roorkee course and making the Survey of India responsible for all survey training from the outset.

In order to get training in quantity going quickly, a first batch of 100 volunteers for the Survey Service was called for in India Army Orders and concurrently a new Survey of India unit, No. 2 Party, was formed at Abbottābād for the sole purpose of training surveyors in field survey work, mainly plane-tabling and military route traversing, etc. To ensure quick results also, the instructional staff of this party was made very strong, far stronger than was normal in peace-time training, really good Survey of India surveyors being allotted in the proportion of one instructor to four trainees, with higher supervision in similar proportion.

Some difficulty was experienced in obtaining suitable accommodation in Abbottābād, but the new party was ready to receive its first batch of trainees in the first half of 1941.

Training of officers meanwhile was continued in the Training School of the Geodetic Branch at Dehra Dūn.

73. Mathematical Instrument Office.—This long established office of the Department celebrated its 110th birthday during this period, to be transferred in May to the Department of Supply ( Munitions Branch ) temporarily for the duration of the war and as a permanent measure immediately after it. This transfer was due to the much wider scope of activities developed during the war, particularly in the realm of manufacture.

With the increasing shortage of sea transport from the end of 1940 and the preoccupation of British instrument manufacturers with works for the defence of Britain, the army in India had perforce to abandon its policy of importing from Britain and pressed us to have the M.I.O. manufacture certain articles like prismatic compasses, binoculars and special gun sights, etc., besides drawing and similar instruments. It was evident that this must be done and a

number of conferences decided on the method ; this much wider field of activity coupled with the preoccupation of the Survey of India with survey and mapping matters led to the transfer away from the Department referred to above.

74. Delhi Conference, January 1941.—This conference was on similar lines to that held in Cairo in 1940 and on the survey side was attended by the Surveyor General of Malaya ( Mr. Bridges ), a representative of Mid-east ( Lt.-Colonel Metford, R.E. ) and representatives of the Survey of India. Survey and map policy was further clarified and co-ordinated as between Malaya, Mid-east and India and resulted in further exchanges of map material between the three areas and in the early despatch to India of four officers of the Malayan Survey for training in air survey and Indian military survey methods. On the other hand, an officer of the Survey of India ( Gemmell ) was sent to Singapore to advise Mr. Bridges on a military survey set-up and to obtain information about maps and map making methods that would assist us in India to provide maximum collaboration and co-operation.

It was also decided that maps of Malaya would continue ( as those of India ) to be on a spherical layout and on inch scales except for smaller scale geographical maps which, as in India, were on the 1/M scale. Maps of Malaya were at this time gridded in two series, north and south, on the Cassini projection ; though this grid is not very suitable for military purposes, it was decided to adhere to it for the present, rather than attempt to make wholesale changes while there was so much else to be done. ( Netherlands East Indies maps were on metric scales however, and carried a Lambert grid ).

75. April-December, 1941.—In April 1941, I took over the duties of Surveyor General of India from Brigadier Sir Clinton Lewis, O.B.E., who proceeded on leave preparatory to retirement. I was relieved in the Frontier Circle by Glennie who in turn was relieved in the Geodetic Branch by Slater and he in the Map Publication Office by Penney. This was to hold good till the end of the war except that Penney, who had to revert to U.K. on account of ill health, was relieved as D.M.P. in 1944 by Gemmell who had previously been in charge of the Photo-Litho Office and later Deputy Director, Map Publication.

I moved to Simla in May along with the Government of India and Army Headquarters, but my Assistant Surveyor General and main office remained in Delhi ; the D.F.C., who was also *ex officio* military Director of Survey ( India ) since June 1940, returned to his main headquarters in Simla for this summer along with the tour office that had been in Delhi during the previous winter.

The Assistant Surveyor General ( Bomford ) was required for military service soon afterwards and was succeeded by a civilian officer recently retired ( Pushong ) who agreed to re-employment in Delhi and remained as A.S.G. till the end of the war.

76. About 70 soldiers out of the hundred called for ( para 72 ) reported for training at Abbottābād, a number of whom had previously been through the Roorkee course and the majority men of some years service in the army. The training principles adopted were to keep one quarter of the batch in headquarters on drawing training, the remainder being in camp in three groups along the road between Abbottābād and Mānsehra where they first carried out very large scale ( elementary ) plane-tabling, followed by smaller scale like 1/25,000 and finally 1-inch scale work. At the end of the course, they were taught route traversing and other special military sketching requirements. No time limit was set for the course and men continued to plane-table till actually required for new units or as reinforcements for old ; to avoid boredom, they were utilized on productive work, revising out of date maps in the area.

Some of this first batch remained as long as 18 months in the party and became very good plane-tablers due to the continuous practice in this one subject ; normally, it took at least three years to make a good plane-tabler because of interruptions during the recess season, when they were employed on fair-drawing. Drawing standards, however, fell off, as was to be expected owing to lack of practice.

The party had some administrative difficulties and much administrative work in dealing with 70 soldiers from nearly as many military units all over India, besides its own Survey of India personnel, but the local military authorities were most helpful in advising and assisting the officer-in-charge, a very experienced re-employed officer ( Mudaliar ), on all military matters.

The terrain about Abbottābād was very suitable for instructional plane-tabling and its climate permitted all the year outdoor work.

77. Air survey training continued in No. 18 Party at Murree, 17 soldiers joining the party for training early in the summer in addition to civilian surveyors and officers under training there. The four Malayan Survey officers also joined early in the summer ( para 74 ) and carried out triangulation and military survey schemes as well as air survey. These four officers returned to Malaya in December a day or so after the Japanese attack on Pearl Harbour.

Increasing numbers of military officers being attached to the Department for training caused the Officers' Training School at Dehra Dūn to be raised to party status, a military officer ( Biddle ) being placed in charge of it late in the year. This unit was primarily intended to give basic training to officers in triangulation, traversing and plane-tabling, which it did in the area about Dehra Dūn-Bhatta-Mussoorie, but by the end of the year was also undertaking more specialized training in military survey duties on similar lines to those previously adopted on the N.W. Frontier ( para 57 ).

The new offices in Risālpur were utilized by No. 4 H.Q. and Company while under formation there and also by the Survey Depot and civil counterpart until they were found offices in military buildings close by.



Some map publication plant and personnel remained in Risālpur during this summer, but the main plant of the Frontier Circle operated in the new offices in Murree under the title "19 Party". A military reproduction group under the control of the Director of Survey ( India ) occupied the Risālpur buildings for a considerable time as well.

78. During the autumn of 1941 a Deputy Director of Survey ( Colonel Heaney ) was sent to 'Irāq to organize for the enlarged survey organization caused by Nos. 4 and 2 H.Q. ( Lt.-Colonels Bomford and Osmaston, R.E. ) and Nos. 4 and 2 Companies ( Majors C. A. K. Wilson and Sams, R.E. ) reinforcing troops already there late in 1941 ; these units were raised at Risālpur and Dehra Dūn respectively.

The formation of these units had depleted our volunteer lists considerably, and some trouble had been experienced in filling vacancies because quite a number of volunteers, while perfectly ready to join up "in their own time", were not willing to join up immediately they were required, and no compulsion could be exercised to make them do so. After some difficulty, a scheme for a Survey Supplementary Reserve was put through which committed volunteers to joining military units when ordered to do so, with penalties under military law for failure to obey orders ; on the other hand, in return for their commitment, volunteers on the reserve were granted a percentage increase of civil pay until called up—this was obviously fair but the system of remuneration for commitment had never been adopted in the past. From then on, we had little difficulty.

79. By the middle of the year, four of the five high speed automatic rotary offset printing machines on order in 1939 had been received and were being installed in the P.Z.O. at Dehra Dūn ( three double-demy ) and P.L.O. in Calcutta ( quad-demy ) the other quad-demy also being ear-marked for Calcutta and received later in the year. Their erection required the scrapping of some old flat-bed machines and ( in the Geodetic Branch ) the construction of a new printing room, to make space for them ; and presented some technical difficulties for our personnel were not familiar with modern high-speed machines. The Imperial Tobacco Company came to the rescue with the loan of one of their erectors from Monghyr in Bihār subsequently replaced, however, by highly skilled erectors from Britain who were on duty for the war with the Corps of Royal Engineers.

To provide suitable machines for the enhanced number of Field Survey Companies we had promised to build up, the War Office had agreed to send us six hand-feed rotary machines ( like those we already had, para 15 ) suitably mounted on M.T. Four of these were in transit before Nos. 2 and 4 Companies were ready to proceed to 'Irāq but we had to do some improvisation with locally obtained army lorries and our own machines to ensure plant being ready to accompany these companies to 'Irāq.

80. Our new printing machinery made a big difference in map output, particularly as maps were now mostly printed only in two colours, black and brown ( para 36 ) ; the limited number of colours coupled with longer runs ( larger demands for each individual map ) made automatic high-speed machinery far more effective than our old low-speed plant, though the latter could compete well when numerous colours and short runs were in vogue. There was already a tendency, however, to revert to multi-colour maps and as map demands became larger with consequent longer runs, our faster machinery made it possible to meet this tendency with efficiency.

A broader audit view of the intrinsic value of maps—not much more than the paper on which they were printed—also enabled us to abandon the policy, initiated early in the war, of bringing maps up to the stage they were ready to publish but not in fact publishing till each particular map was demanded. During 1941 we began to build up stock-piles of maps, over  $1\frac{1}{4}$  million being printed in the four months April-July alone. This, however, brought in its train another set of problems, paper supply and storage, and map storage and issue ; paper supply from Britain was virtually cut off and our storage and issue facilities were not designed for handling large bulk quantities of maps. The latter problem was dealt with by building or hiring ( in Calcutta ) extra space while reorganizing somewhat our previously detailed issue M.R.I.O., and Map Issue Section in Dehra Dūn ; the former, by creating a small stores organization in Calcutta to handle the paper situation while enlisting the help of paper mills at Titāgarh to produce a paper that could be made from Indian materials and would be suitable for map purposes.

The upshot was the fine map paper, made almost entirely from bamboo and known as “Super-calendered Ahmadābādi”, on which most of our maps were printed thereafter and also many tons of maps produced in Mid-east and other war theatres ; and the expansion of our stores organization to handle all types of survey and map publication instruments, equipment and material with headquarters at Dehra Dūn. This organization replaced the Mathematical Instrument Office ( para 73 ) in respect of local purchase, storage and issue but continued to rely on the M.I.O. for manufacture, specialized local purchase and technical inspection of surveying and mathematical instruments.

81. The great majority of maps printed were of course on special order for the army and consequently were charged for at publication cost plus 5% ( para 39 ) to which was added a charge for drawing and transportation. With the great increase occurring in 1941, this system became unwieldy and wasted too much time in accounting ; carriage and storage costs also were almost impossible to keep track of and as often as not maps were fetched by a military lorry or despatched by rail on military credit note.

It was therefore decided to “flat-rate” all maps sold to the army, to include drawing, publication and carriage costs

irrespective of size of maps, number of colours and number of copies of each map. At the outset, a charge of annas eight per map was fixed ; the next year and thereafter the charge was fixed at annas six per map, owing to greater volume. A careful check towards the end of the war showed this charge to represent very closely the actual cost of production.

By this system, budgetting was easy and accounting labour negligible. When the military authorities made their estimates of maps required for any year they knew exactly what those maps would cost them and the Survey of India knew exactly what funds it would have to apply to map making machinery, paper, inks, etc.

The Government of India required that the rate be reviewed each financial year before budgetting was commenced.

Map series specially prepared for the armed forces were now called "HIND" series to distinguish from regular Survey of India series and between identical maps published by other organizations ( e.g., War Office, Mid-east ) each of which had its own distinctive title.

82. Maps not ordinarily available to the general public for security reasons were called in India "For Official Use Only" ( "F.O.U.O." ) and a further category "F.O.U.O.-B" had been added in 1940 covering a much wider area than the regular F.O.U.O., but with less rigid regulations for their issue. In 1941, the term "Not to be published" ( "N.T.B.P." ) was adopted in Britain and conformed to by Burma but India decided to adhere to F.O.U.O. as more expressive at least in respect of maps, though accepting N.T.B.P. for letterpress publications. Eventually, when a complete overhaul was made of the classification of documents to conform to American practice, the term "Restricted" was adopted for all documents not generally available to the public that were not of such security importance as to be classified Confidential, Secret or Top Secret.

83. There was at this time pressure from within and without the Survey of India to put our military personnel into uniform. Though I had myself made this suggestion in 1940 when I was D.F.C. ( para 64 ) I was unable to accept it in 1941 after very careful consideration and consultation with the Department of E.H. & L. The Survey of India being a civil department under the civil E.H. & L., with the vast majority of its personnel civilians it could hardly be interpreted otherwise than as a slur on the war effort of civilians if a few of us wore uniform while performing our civil duties. This is not to suggest that any pressure was brought to bear by the E.H. & L. Department ; on the contrary, the Hon. Member left it entirely to me. There was also the decisive factor that it could not possibly make for good discipline and relations if, as happened, a military Major was officiating in the civil appointment of Director, Survey of India, which ranked with full Colonel, and was consulted in his own office by a Lt.-Colonel ( war acting

promotion ) who was actually a Captain in his own right and many years junior in the army to the Major officiating as Director.

Until the end of the war repeated attempts, all unsuccessful, were made to have temporary rank granted to military officers in civil employ on the same lines as in the army, both to meet the problem just discussed and to permit easier and quicker exchange of officers between civil and military to cope with changing survey situations.

Military officers of the Department were, therefore, permitted to wear uniform or civilian clothing, at their own discretion. No orders were issued one way or the other.

As regards security, far more care was taken before a person in civilian clothes was admitted to General H.Q. than in the case of a person in uniform ; on one occasion, travelling in a crowded train, a military officer from G.H.Q., in uniform, was more than surprised when I insisted on seeing his G.H.Q. pass before permitting him to travel in my reserved compartment. This was an elementary security measure, for I had many official papers with me for action during the journey, some of which were secret.

84. In June 1941, the officer-in-charge of the Burma Survey Party ( Major Wright ) was made Assistant Director, Survey of India, in Burma the party being taken over by a senior and experienced civil officer ( Murphy ). A military officer ( Thackwell ) had previously been sent to Burma to assist in military training and during the course of the year staff was augmented by some trained air survey personnel and by a small ( hand press ) map publication section. Considerable rapid revision of maps on lines of approach from the east was in progress, using air photographs previously taken by Messrs. Indian Air Survey and Transport Company, Ltd., of Dum Dum ( Calcutta ) and some specially taken in 1941 for the purpose.

In December, I went to Burma to carry out the usual annual Surveyor General's inspection of the Burma Survey Party, and preliminary discussions with Army Headquarters at Mingaladon ( Rangoon ) cleared the way for the quick passage of special war establishments compiled in consultation with Wright and Thackwell at party headquarters at Maymyo and handed in to A.H.Q. on my return journey.

I also had discussions with the Department of Education, Health and Lands under whose orders the Burma Survey Party functioned, and with the Defence Department and the Map Curator and Stationery Department in connection with map storage and distribution and the possibility of utilizing their plant for topographical map publication ; they had little experience of publication in colours, however, and proposals to transfer one of their flat-bed machines to Maymyo, for operation by our own personnel, followed.

I returned to India the day the Japanese attacked Pearl Harbour, Rangoon being completely blacked out the night before I left. The four officers of the Malayan Survey were in Calcutta and left shortly after for Malaya. Burma map problems were discussed in Calcutta before returning to Delhi.

## CHAPTER VII

WAR, 1942

85. **Burma.**—In February, No. 6 Indian Field Survey Company ( Major Thackwell, R.E. ) was raised from the Burma Survey Party, with some assistance in personnel from India, and No. 6 Headquarters ( Lt.-Colonel Wright, R.E. ) which like other survey headquarters as envisaged before and early in the war was an Assistant Directorate. Wright continued also to function as the civil Assistant Director, Burma, maintaining continuity and the link with the Government of Burma and the Surveyor General.

Army Headquarters, Burma, desired that maps should be sent to them instead of to the Map Curator as in the past and altogether nearly half a million maps were supplied, about 5 tons being sent by air. Through lack of distribution facilities, few reached the fighting troops until a Map Supply Section ( Lt. Jardine, R.E. ) was sent from India and another formed in Maymyo from local resources by Lt.-Colonel Wright. Many thousands of maps had to be destroyed to prevent capture by the Japanese.

No. 6 Company and the Burma Survey Party carried out some hasty reproduction ( hand presses ) to meet immediate demands but, speaking generally, operations moved too fast to permit much survey or map work to be done.

86. The survey offices in Maymyo were bombed during the fighting but slit trenches and blast walls prevented more than superficial damage. The bombing did, however, result in a considerable number of personnel absconding to their homes ; some returned before the final evacuation of Burma but many did not.

When evacuation was ordered, the personnel of the Burma Survey Party were given the option of returning to India with No. 6 Company and Headquarters or remaining in Burma ; a number elected to do the latter and were given an advance of pay and instructions to report when Burma was reoccupied.

Survey records were hidden in a remote Forest Rest House in the vicinity of Rytikyma except for the fair drawings of all maps which Lt.-Colonel Wright succeeded in evacuating to India by air. The records were not found after the war, having presumably been located by the Japanese or pilfered by local people.

87. Evacuation was carried out in three echelons under the command of Lt.-Colonel Wright, Major Thackwell and Mr. Murphy ( the officer-in-charge, Burma Survey Party ) and was by rail part way and thence on foot from the Chindwin over to Manipur in Assam. There were some men and their family members killed and

hurt in the railway wreck that occurred near Monywa but otherwise the parties managed to get through safely, though somewhat exhausted. They were helped on the way by relief organizations that had been established on the various land evacuation routes by the Governments of India and Assam and the Red Cross and on arrival in India were dispersed to their homes on leave to recuperate for a short time, while arrangements were under way to reform and re-equip the military units under Eastern Army auspices at Rānchi and to set up a nucleus headquarters of the Burma Survey Party to deal with accounts, compensation, etc. This H.Q. (Murphy) was first established at Calcutta and later moved to Dehra Dūn when Mr. Murphy assumed charge of No. 2 D.O. there; civilians of the Burma Survey Party were distributed to other units of the Department on their return from leave.

The Map supply Section (Jardine), however, had been forced northwards to Myitkyina and no word of them was received after 5th May; this section remained prisoners of war until VJ some members working on the "Death Railway" in Siam.

88. Reorientation.—The entry of Japan and the U.S.A. into the war caused much reorientation followed by reorganization and expansion in India.

Early in 1942 a visit from Brigadier R. L. Brown, Director of Survey, Mid-east during which further requirements for Mid-east were discussed and his experience in charge of a large survey Base Organization there drawn upon, led to arrangements being made for heavy reinforcement of India with high speed printing machinery and the creation for the first time in India of a military survey service as such, with a view to making India a survey as well as operational base for eastward moves while at the same time continuing its role of supporting base for Mid-east.

By this time Mid-east troops were well established in 'Irāq and Irān and, to free India for more active effort to the east, Mid-east assumed responsibility for all maps as far east as longitude  $54^{\circ}$ , a line passing roughly through the east shore of the Caspian Sea and Yezd in Irān. Hitherto, we had been responsible to  $48^{\circ}$  which gave us nearly the whole of Irān; the new responsibilities relieved us of about half of it.

When the South-west Pacific Command was formed early in 1942, one of our officers (Colonel Bomford) who had gone to 'Irāq with No. 4 H.Q., was appointed Deputy Director of Survey for the new Command. He remained but a short time in Java, however, returning when Java was evacuated to take over the post of D.D. Svy. Eastern Army at Rānchi; No. 6 Company and Headquarters from Burma (para 87) were reformed under his control and raising orders for a new company and H.Q. (No. 3) issued.

Colonel Bomford brought with him very valuable cartographic records of N.E.I.

89. Map output of course increased greatly in Burma and eastern India areas. The stock-piling principle now became firmly established ( para 80 ) and, as more machinery became available so we tended again to more and more colours on the maps. "Farming" of map printing was resorted to in order to augment our own resources but was not highly successful at this stage because the private lithographic trade was little developed—and we were in competition with other government services whose demands were not so exacting as ours for accuracy of registration, etc., and over which we had no control—and the only provincial government office well accustomed to production of maps in colour ( Madras ) had much work of its own to do. Later, this office published many maps on our behalf.

It was equally hard to obtain recruits for our expanding publication staff from the trade in India or from the provinces. Few men had experience of colour map work, none were accustomed to precise registration requirements ( except perhaps Madras ) and all reproduction plants were busy ; in general, our pay rates were considerably lower, skill for skill, than those of the trade. Had we been able to guarantee continued government service and hence pensions to men from the trade, the picture might have been different ; but we could not do so.

We had therefore to augment our staff by bringing in Royal Engineer personnel, from the British trade ( para 91 ).

90. Japanese air raids on Calcutta caused us no damage in material or personnel, but did cause considerable damage in the sense that much time that should have been devoted to technical work was spent on A.R.P. works, fire-watching and the like ; they did, however, bring one good thing in their train—dispersed storage of paper and maps in Calcutta by hiring storage space.

Neither the Joint Secretary ( Oulsnam ) of the Department of Education, Health and Lands nor I could, however, see the merit of continuing to work in difficult conditions, particularly as the great expansion envisaged must in any case necessitate new construction ; or of risking loss of everything if the Japanese did succeed in landing in India. It was therefore decided to build a new "Map Factory" at Dehra Dūn on a piece of property ( Hāthibarkala Estate ) that had been earmarked for the Survey of India for many years to enable it to transfer its whole main activities to Dehra Dūn, never actually done.

This factory was established with almost incredible speed, to house eight to ten high speed rotary offset printing machines with all necessary ancillary equipment, drawing and administrative offices, etc, and living accommodation for about 3,000 persons. Design was started in March 1942 and by November, much of the building had been done. By the middle of 1943 the factory was in operation with three large high-speed machines, followed soon after by a number of others. This "Operation Hāthibarkala" was made possible and successful by the continued close co-operation of the Education, Health and Lands and Finance Departments of the Government of



India, the Central and United Provinces Provincial Public Works Departments and the War Office who supplied most of the machinery and plant and technical stores ; and by the strenuous efforts of our original planners, Penney and Crone and, as soon as building was started, Gemmell who took over the post of Deputy Director in charge of this project.

91. It has been mentioned ( para 89 ) that we could obtain little reinforcement in personnel for map publication in India and that our own personnel had little knowledge of erecting or operating modern high speed printing machinery ( para 79 ). Arrangements were therefore made with the War Office to send us officers and other ranks of the Royal Engineers, to accommodate whom special attached cadres were formed ; these cadres were paid at military rates, drew military rations, etc., but were controlled by the Survey of India and, since we were charging for maps supplied to the army, their cost was defrayed by the Department. At the outset, these officers and men were employed in Calcutta and the Geodetic Branch publication offices at Dehra Dūn ( P.Z.O. ) but as the Hāthibarkala factory took shape, more and more British personnel were transferred there to operate it, and to instruct our own operators.

During the year, the officers' cadre was expanded to accommodate officers attached for training and also militarized Survey of India officers who were required temporarily to meet special survey or training requirements, so as to avoid the very cumbersome procedure of demobilizing them only to re-mobilize when the special necessity had passed.

92. Map demands in eastern India areas increased greatly as the Burma retreat progressed and the fall of Singapore became imminent. In March, when bases were being established in north-east Assam and considerable numbers of troops were accumulating there, it became evident that survey assistance was going to be required. With the approval of the Government of India, I therefore made ready for the field a party of the Eastern Circle, No. 12 ( Strong ), and had just despatched it to Jorhāt in Assam to undertake whatever work it might be called upon there to do when a most urgent request for assistance came in, via the Government of India, from General Wood who was at that time organizing in Assam under the direct orders of the Government ; it was with no little satisfaction that I was able to wire in reply that a party was already on its way and Mr. Strong would report for orders in the next day or so.

This party carried out a multitude of surveys of every sort in the Assam Valley and about Ledo and Mārgherita under very difficult conditions.

At this time too, a small Survey of India detachment ( Alexander ) was on its way to Kalewa on the Chindwin to carry out some urgent work there, when it met one of the evacuation echelons from Burma. The detachment proceeded to Kalewa and after completing the work allotted to it, returned to Assam.

93. Meanwhile, No. 20 (Cantonments) Detachment had broken off its routine programme of cantonments surveys as economically as possible and, raised to party status, was supplying small detachments of skilled large scale and traverse, etc., surveyors to Chief Engineers of military Commands to carry out urgent surveys for military installations under their control, though continuing to be administered and technically controlled by the Director, Geodetic Branch. Allotment of personnel was broadly directed by the Engineer-in-Chief.

Detachments from this unit also assisted in Assam and Eastern Bengal during this period, though much of their work was in the west and south of India.

The Cantonments Party continued in this rôle for the remainder of the war, carrying out some hundreds of surveys of different sorts before its end on which it utilized elderly surveyors, many of them re-employed, who were physically not up to more active military survey work but on the other hand were experienced and trustworthy men capable of working with little supervision.

94. Reorganization.—The main Government of India and General Headquarters offices remained in New Delhi during the summer of 1942 and thereafter, only offices less directly concerned with the prosecution of the war being housed in Simla, to make room for the steady expansion in New Delhi overflowing to Delhi. The Surveyor General's office and that of the Director, Frontier Circle were now established in hutments in (old) Delhi, behind the Temporary Secretariat, built about 1911 to house the Government of India while New Delhi was in process of building. These hutments were hot in summer, cold in winter ; but they gave us elbow room, so necessary in a survey office, and were not so far from the Main Secretariat ( 6 miles ) as to cause serious inconvenience, telephone connections being good ( automatic system ) and even with petrol rationing there was seldom difficulty in making a journey to New Delhi when necessary.

By the end of 1941 it had become obvious that, with the much wider military commitments accepted by the Survey of India for the war ( para 58 ), it was quite wrong that the *Frontier Circle* should continue to be responsible for all military survey matters, suitable as that was when commitments were in fact confined to the Frontier ( i.e., N.W. Frontier of India ). For a short time an experiment was tried of splitting the Frontier Circle into two, a Training Circle and ( still ) a "Frontier" Circle ; the former responsible for all training, the latter for all other military matters. This was my own idea and was a bad one, though it did serve to pave the way for the ultimate and proper transition of military responsibility ( so far as the Survey of India was concerned ) from the N.W. Frontier pure and simple to a wider military outlook on responsibilities. The necessity for a purely military organization, however, brought in its train the necessity for a "Military Circle" ; this we could not escape, for whatever the *military* set-up might be it was

essential to have some organization headed by a senior officer that would relieve the Surveyor General of the large amount of administration caused by mobilizing and demobilizing personnel and looking after pay, promotion, etc., of mobilized personnel; in fact, a "military" staff for the S.G. It was called a "Circle" only to conform to the existing organization of the Department and to give its head the normal status of Director.

The Director, Frontier Circle (Glennie) took charge of the new Military Circle in Delhi, the Frontier Circle headquarters moving to our newly built offices at Murree. Thereafter, the Frontier Circle dealt as usual with all works in the north-west and in addition kept Northern Command (North-west Army) supplied with maps of its area besides organizing all training in No. 2 (Surveyors' Training) Party and No. 18 (Air Survey) Party.

At this time, too, a special work was undertaken for the N.W.F.P. Government, the settlement survey of a part of Hazāra District so hilly as to require more complicated trigonometrical control than the settlement survey staff itself could undertake. This work provided excellent advanced training in triangulation and traverse and their computations, and for this reason was executed on a special Lambert projection (instead of the usual Cassini for such work) to accustom trainees to working in grid terms (para 32).

95. In May, the War Office sent us Major M. O. Collins, R.E., who had had considerable experience in the Geographical Section, General Staff at the War Office, to help us in forming a similar organization in India; no military post could be found for him at once, so he was brought into the Department in a special civil post created at 24 hours notice on the pay and with the departmental seniority that followed his military seniority, as for other military officers in civil employ.

When establishments for the G.S.G.S. were worked out and approved, Collins reverted to normal military employ along with others selected to fill the vacancies in this new, purely military, establishment. The G.S.G.S. was headed by a military Director of Survey (India); after some debate, it was decided he would also remain the Director, Military Circle with a civil staff headed by an Assistant Director, for which we were fortunate in having Colonel R. H. Phillimore, C.I.E., D.S.O., a retired director (and officiating S.G.) of the Department who had volunteered for re-employment.

Colonel Glennie thus functioned in two capacities, being responsible to the Surveyor General for the administration of Survey of India personnel in military employ and to the C.G.S. through the D.M.O. for all other military matters. Power was also delegated to him to demand maps from the Director, Map Publication on behalf of the Surveyor General and later on he took over control of the civil Stores Office. He also administered the Survey Depot and civil counterpart (Survey Training Centre) and the attached cadres of officers and B.O.R.'s (para 91).

Thanks to the Department of E.H. & L., we were able to obtain for the G.S.G.S. the Archaeological Museum in the upper floor of the Imperial Records Building, New Delhi which was about a mile from G.H.Q. and about 5 miles from the S.G.O. and Military Circle Office, the two latter being side by side.

By the latter part of the year the G.S.G.S. was well established in this excellent office, with plenty of elbow room, and our library of exploration and other foreign maps had been transferred there from Dehra Dūn, to augment the library they were themselves building up.

Two good sized buildings were also put up under Survey of India auspices close to the M.C. Office, to serve as a military Central Map Depot. From then on, most of the maps published at Dehra Dūn were delivered in bulk to the C.M.D. by lorry whence they were distributed under G.S.G.S. arrangements; maps published at Calcutta were also stored in the C.M.D. unless required to be sent direct to the forward depots.

96. Before the war, the Survey of India had no motor transport of its own except two very old lorries that had been used in surveying portions of Baluchistān reachable only by road. In 1942 a station wagon was acquired for the Frontier Circle which made inspection of training units much easier and about the same time other lorries were purchased and a number of miscellaneous vehicles taken on loan from the army for the transport of machinery and maps and paper; by the end of the war, we had a considerable fleet of bought, begged and borrowed vehicles—possibly even stolen! We could never have delivered the goods without them. The G.S.G.S. also had one or two vehicles of its own besides access to the military pool at G.H.Q. so that even when petrol rationing became severe and private vehicles difficult to utilize, we were usually all right for transport.

I made it a practice to make regular visits to Dehra Dūn for 4 or 5 days in each month for technical and administrative discussions and a routine conference. This saved much correspondence time and kept the bulk of the Department always up-to-date on policy and happenings in Delhi; with some difficulty, I was permitted to have enough petrol to use my car for these visits—four hours or less by road, a dreadful night in the train, often hours late.

I also visited Murree and Abbottābād three or four times in each year to see training at first hand; these visits had to be made by train as far as Rāwalpindi using the new station wagon from Pindi onwards.

There was always much work to be done in the train, mountains of files greeting me at Pindi and Lahore as a rule.

97. The Officers' Training Party, in which were several officers of the Royal Engineers (E.C.) and Indian Army who had previous survey experience, was functioning at Chakrāta instead of Dehra Dūn—Mussoorie this summer because of an outbreak of suspected cholera in the area usually used for summer plane-tabling. I had not liked the

terrain near Mussoorie particularly and though Chakrāta was better, both were too "big" for mass instruction ; it took too long to get from one plane-table fixing to another making close instruction difficult and it was hard to find areas suitable for tactical exercises. The monsoon was also heavy. I therefore decided to move this unit to Abbottābād in the Frontier Circle, where it could work alongside the Surveyors' Training Party and was handy to the Hazāra Detachment for advanced theodolite work and to No. 18 Party for air survey work ( para 94 ).

This unit, renamed No. 4 Party, had summer headquarters in camp near Mānsehra and winter headquarters near Havelian for the remainder of the war.

98. Demands for air photographs for which service aircraft could not be spared had become heavy, not only for survey purposes but also to test camouflage on installations, etc., and at the same time the Royal Air Force were establishing in New Delhi a library of all available air photos from Calcutta eastwards.

Operating from Dum Dum, Bengal, was the Indian Air Survey and Transport Company, Ltd. ( Mr. Kemp ) which possessed some "Moth" aircraft, skilled survey photography pilots and a small ground survey establishment as well as a photo-processing establishment that was mobile ; this company had taken many thousands of photographs of all parts of India and Burma some of which were its own property, some the property of the Survey of India and some belonging to various other clients, notably oil companies and the Government of Bengal.

A proposal to charter the survey resources of the company and acquire on loan for the R.A.F. library all photos east of Calcutta was quickly agreed to by the Government of India, the R.A.F. and Army Headquarters and from October 1942 this charter became operative, giving us the use of two photographic aircraft ( Tiger Moths ) and one reconnaissance aircraft ( Hornet Moth ) which proved invaluable immediately on work in the Sundarbans and Eastern Irān and later on a multitude of post-war reconstruction and irrigation survey jobs.

Messrs. I.A.S.T. took, during the war and immediately after it, a total of 54,962 photographs demanded by the Survey of India and, through us, by the military services.

99. Afghānistān.—The Afghān Detachment ( Chiragh Shah ) completed field work in 1941 and during 1942 map publication was completed, maps being published in two editions, English and Persian.

100. 'Irāq-Irān.—Various changes were made in the establishments and nomenclature of units that had been organized and raised by the Survey of India for service in 'Irāq-Irān under the control of Colonel Heaney ( D.D. Svy. ) operating under Mid-east orders but essentially the strength of these units remained the same, namely three companies plus Colonel Heaney's own headquarters, one Map Supply Section, one Survey Park Section and one Drawing

Section. It has been mentioned ( para 88 ) that Survey of India map responsibility was shifted eastwards  $6^{\circ}$  of longitude to relieve it of the western half of Irān during 1942.

The units had carried out a large amount of survey and triangulation, besides drawing and publication and had become to some extent intermingled with Mid-east ( British ) units, one Survey of India officer commanding a British unit in Syria, another forming a new survey company of Palestinians and another acting as survey instructor to British trainees in 'Irāq-Irān.

By the end of the year, preparations were in train for reverting Survey of India units to India for service in South-east Asia areas and the taking over by Mid-east with British survey troops of all operations west of longitude  $54^{\circ}$  E.

101. Late in 1942 the newly raised No. 3 Indian Field Survey Company ( Major Biddle, R.E. ) was sent to the Irān-Baluchistān border along with a specially formed party of the Survey of India, the Perso-Baloch Party, ( Strong ) to carry out rapid correction survey in respect of communications in that area and some triangulation to control air photography put in hand under our charter with Messrs. I.A.S.T. ( para 98 ).

## CHAPTER VIII

### WAR, 1943: JANUARY-AUGUST

102. *Introductory.*—1942 saw much reorganization due to reorientation of outlook eastwards ; the earlier part of 1943 saw few major reorganizations but a number of minor ones to improve the broad decisions of 1942, to implement the latter fully and to consolidate and expand into a strong and sound survey Base Organization with a strong and sound military survey service ready to move forward when the time came.

Map drawing and publication was very heavy during the latter part of 1942 and the earlier period of 1943, both to provide the maps necessary for the defence of India and Ceylon and to lay the foundations for long term requirements in Burma, Siam, French Indo-China, Malaya and the Netherlands East Indies. The volume of scientific work now also began to increase sharply to provide the necessary information about grids, triangulation data, tidal and magnetic data in this large area of South-east Asia ; and very many surveys were required in eastern India from N.E. Assam to Madras and beyond in connection with roads, railways, airfields, depots, camps and other military construction works.

This chapter, treated on somewhat different lines from those preceding it, is therefore in the nature of an introduction to what might be called the second half of the war as it affected India.

103. *'Irāq-Irān.*—By August 1943, the majority of Survey of India units and personnel had been withdrawn from Mid-east and were reorganizing and refitting in India preparatory to forward movement, or were employed in Eastern and Southern Armies on works connected with the possible invasion of India by the Japanese forces. One Map Reproduction Section was left in Irān under the control of *Paiforce* (Mid-east) as well as a few other Survey of India personnel employed on special tasks.

During their time in 'Irāq-Irān, these units formed from the Department during 1940 and 1941 carried out a very large amount of field survey work under very diverse climatic conditions, temperatures ranging from zero to 127 degrees Fahrenheit, and in all types of terrain. About 220,000 sq. miles of plane-table survey on the  $\frac{1}{4}$ -inch or 1/100,000 scales (sometimes both) was completed together with the necessary triangulation and its computation. In addition they mapped about 4,500 sq. miles from air photographs, on the 1/50,000 and 1/25,000 scales ; and published many thousands of maps.

No. 3 Indian Field Survey Company and the (civil) Perso-Baloch Party (para 101) completed their work early in the year



and returned to India. During the course of this work Major Biddle tried to make a triangulation connection between India and Irān across the Lūt Desert, but had to abandon the attempt because of excessive haze and heat.

104. **Ground surveys in India.**—There was no routine topographical programme ; surveys for airfields, depots, etc. ( para 102 ) were undertaken in about 50 different places in India—sometimes more than one piece of work at the same “place”, for instance an airfield survey, a camp survey and a survey for an arsenal at a single “place” and some ground revision was also done in various parts. Though the majority of this work was in eastern India from Assam to Madras and beyond, surveys for prisoners of war camps in other parts of India, for training areas, artillery practice ranges and the like were many. Besides this work done by the civil units of the Survey of India ( mainly No. 20 and 12 Parties ), many similar works were carried out by Nos. 3 and 6 Companies and, later, by other companies on their return from Irāq.

The Lahore Survey Detachment of the Frontier Circle ( para 12 ) had by this time completed its field work and been disbanded ( final drawing being in the hands of the Eastern Circle at Dehra Dūn, used as a back-log of drawing during the lulls in military work ) ; the Hazāra Detachment, however ( para 94 ) had still in progress the settlement survey control programme of that district of the N.W.F.P. and was providing excellent advanced theodolite training for officers.

105. **Training in field work.**—The grouping of field survey training about Abbottābād ( paras 97, 94 ) was proving very satisfactory and by the middle of 1943 a steady routine had been established both in the surveyors' party ( No. 2 ) and officers' party ( No. 4 ). This routine had to be varied a little from time to time to meet fluctuating demands from the D. Svy. for reinforcements but speaking generally we aimed at about 12 months training for surveyors and about 3–6 months for officers, some of which might or might not be air survey training in No. 18 Party at Murree. Naturally, standards achieved were nothing like as high as pre-war but we crammed as much as we could into the courses and the D. Svy. was usually able to ensure that some further training was carried out after personnel had joined their military units. In particular, it was necessary for the eastern theatre to give some further training in jungle survey, the Abbottābād area not being densely wooded—which was one of the main reasons for accepting it for elementary instruction.

Surveyors ( plane-tablers ) were taught the elements of the art on large scale, followed by about 3 or more months on medium scales and thereafter on small scales like 1-inch for as long as they could be retained. Military route sketching training was practically dropped for by now we were training primarily to meet the needs of the Survey Service proper, and time did not permit of everything.

Military Officers were now coming mainly from Britain and had usually had elementary training there in instrumental work but were very weak on plane-tabling. This fitted in well enough, for our own officers ( Class II and Topo. Assistant recruits ) had to be taught plane-tabling from the beginning, followed by instrumental work ; the two sets of officers, therefore, worked together on plane-tabling, the British officers being given a short refresher on instrumental work while our own officers were given more protracted training in that branch, usually followed by advanced ( productive ) work in the Hazāra Detachment.

Recruitment of our own Class II officers, much expanded, was now through the Public Services Commission, of our Topo. Assistants ( a temporary, non-gazetted service ) directly by the Surveyor General ; the essential educational qualification for the latter was intermediate with mathematics, but many of them had university degrees. A stipulation in the recruitment of Topo. Assistants was that they must, on recruitment, join the Survey Supplementary Reserve ( para 78 ).

One Chinese officer, Lt. Wong, was trained on the same lines as our own officers ; he had no English or Urdu and his instructor had no Chinese ; somehow, they managed to understand each other and Wong turned out to be a good plane-tabler. .

Instructors by this time were beginning to run short through mobilization to military units and advancing age slowing down the more senior men on the hills ; the return of units from 'Irāq helped materially in this respect. There were many more rejects, too, from among the batches of soldiers recruited every eight months or so for training and the men were younger and not so steady as the first batches ; this in itself threw a heavier burden on the instructors and officers of No. 2 Party and eventually resulted in the formation of a military administrative section in the party, whose O.C. also performed the duties of a Survey of India "Camp Officer", in charge of several instructional sections.

106. Air survey.—Tests for stereoscopic vision were carried out in Nos. 2 and 4 Parties during the course of field survey training and those who passed the tests were sent on to No. 18 ( Air Survey ) Party at Murree for air survey training ; those unable to pass the tests continued field training as long as possible if they were good at field work, otherwise were transferred to other survey duties ; a number of draftsmen were required for miscellaneous duties in the various military headquarters and it was desirable that the personnel of Map Supply Sections and Survey Park Sections should have at least some survey and drawing experience.

The great majority of those who were competent in field work did pass the air survey tests ; speaking generally it was found to be a waste of time to train non-field men such as draftsmen in air survey work, except for the very simplest tasks ; they lacked the topographical sense that only field training can provide. Our aim was to teach the rudiments of air survey work in its simplest form but

in all its steps ; that is, to turn out air surveyors who were familiar with the making of an air map in all its stages. A few of the most receptive were given further training in some of the more complicated processes such as working from oblique photographs.

Many draftsmen were, however, taught to make good use of air photographs for special purposes such as for military intelligence work.

107. Training absorbed most of 18 Party's time from 1943 onwards. Nevertheless it was able to undertake some productive work for the D. Svy. and sporadically to continue improvement of the Tribal Area maps, the work on which it had been engaged before the war ; these latter works provided advanced training for men not immediately required to form or reinforce military units.

Early in 1943, the party was pretty well denuded of trained personnel by the formation of an Air Survey Deputy Directorate ( No. 12 ) and No. 5 Indian Air Survey Company followed by the partial formation of No. 7 Company, also on a special Air Survey ( as opposed to Field Survey ) establishment. This step was rendered necessary by the increasing amount of photo material becoming available from eastern India and Burma and urgent map requirements in those areas on scales larger than the existing 1-inch maps.

108. The Directorate ( Colonel Crone ) was found space in the new Hāthibarkala offices in Dehra Dūn, now nearing completion ( para 90 ) and No. 5 Company ( Major R. S. Kalha ) was housed on the Castle Hill Estate at Mussoorie in the buildings previously used by the Survey of India Central Circle and placed at our disposal by the Central Public Works Department with the approval of the Government of India. Some structural alterations were necessary to adapt some of these buildings as living accommodation for the personnel of No. 5 Company and, because of the necessity for electric heating and shortage of power, they were somewhat cold in winter ( Mussoorie is 7,000 feet up ) but served our purpose well. There was a small sports ground used also as a parade ground and the hilly nature of the estate gave needed exercise to this unit, engaged as it was wholly on office work.

109. A new post of Air Survey Officer, Survey of India, was created to co-ordinate the work in the Department and operate the charter with Messrs. I.A.S.T. ( para 98 ) and to act as air survey adviser to the Surveyor General. By arrangement with the Director of Survey ( India ) this post was filled by Crone in addition to his duties as Deputy Director, Air Survey Directorate ; he was able at the same time to co-ordinate work between military and civil to prevent overlapping.

110. Military units.—On 31st July, 1943 the following military survey units, mainly formed from Survey of India personnel, were under the control of the Director of Survey ( Glennie ) :—

Geographical Section, General Staff ( Delhi ).  
Survey Depot ( Dehra Dūn ).

Central Map Depot ( Delhi ).  
 3 Army type Survey Directorates.  
 1 Corps type Survey Directorate.  
 1 Air Survey Directorate.  
 5 Field Survey Companies.  
 1½ Air Survey Company.  
 4 Map Supply Sections.  
 2 Survey Park Sections.

These units contained 622 Survey of India personnel *excluding* Class IV service personnel ( khalāsīs, etc. ). This total however includes about 100 soldier surveyors who, though not technically members of the Survey of India, were recruited from the army by the Survey of India and trained by it in supersession of normal recruitment arrangement ( para 72 ).

111. In his civil capacity as Director, Military Circle ( para 95 ) Colonel Glennie operated the Supplementary Survey Reserve ( para 78 ) and also controlled on behalf of the Surveyor General the Civil Survey Depot ( Survey Training Centre ) and the three attached military cadres :—

Officer Cadre—1 major, 3 captains, 6 subalterns.

V.C.O./Havildar Cadre—5 subedars, 20 jemadars and havildars.

B.O.R. Cadre—On 31st July, 1943, 64 vacancies filled, out of 88 sanctioned posts.

112. The B.O.R. Cadre was still partly in Calcutta ( para 91 ) but as the Hāthibarkala factory became established and the Geodetic Branch publication office ( P.Z.O. ) steadily expanded, more and more personnel of this cadre were employed in Dehra Dūn on the erection of new machinery, operating modern machinery with which our men were not very familiar and teaching our men to use this machinery.

This cadre had been living in tents in the compound of the Geodetic Branch and had accepted these rather uncomfortable arrangements philosophically ; arrangements were made in 1943, however, for new barracks to be built across the road from the G.B. Compound, to house this cadre now of considerable proportions.

Survey of India total strength at this time, including attached and those in military units but excluding Class IV service personnel, was 2,338 as compared with 1,400 pre-war, see Table C.

113. **Publication.**—Letterpress publication was becoming heavy in 1943, though not of the proportions it reached later on, in the publication of triangulation and other data required east of India ; the move to Hāthibarkala of the main map publication offices in Calcutta, which had a small letterpress section besides that in the Geodetic Branch at Dehra Dūn, suggested concentrating all letterpress work in the latter office and steps were being taken to modernize and improve its machinery. A “Monotype” casting machine had been purchased early in the war and was giving very

useful service in setting up letterpress work and also casting type for use in the drawing offices—it was normal Survey of India practice to *hand-type* all names on maps, implying importation of type until we obtained the Monotype machine.

114. Work was progressing favourably on the installation of machinery and plant at Hāthibarkala and also in expanding and reorganizing the P.Z.O. of the Geodetic Branch. A considerable number of personnel were transferred from Calcutta to Hāthibarkala during the early part of 1943 and were housed there fairly comfortably though a very severe storm early in January caused some flooding of buildings and damage ; roofs were bitumen proofed in good time before the monsoon and thereafter there were no more leaks than might be expected in any buildings of a temporary nature.

By the end of July there were in operation or under installation five quad-demy rotary offset machines of which two ( in Hāthibarkala ) were 2-colour machines ; of the single colour machines, two were in Calcutta, the other in Hāthibarkala. There were also three double-demy single colour machines in the P.Z.O. ( Geodetic Branch ) and two 2-colour demy machines. And, spread between the various offices, eight hand-feed medium speed double-demy rotary offset machines and ten flatbed machines. ( Compare para 21 ).

Military survey units had been equipped with lorry-borne equipment similar to that used by the British survey companies and had in action by the end of July eight single-colour high speed rotary offset machines ; there was also in military employ one double-demy medium speed machine and one flatbed machine, transferred to the G.S.G.S. with the Army Section of No. 6 Drawing Office, early in the year ( para 26 ).

115. It has been mentioned that map publication was very heavy about this time ; during the twelve months ending 31st July, 1943, the Survey of India published  $20\frac{1}{2}$  million maps and the military publication offices  $1\frac{1}{2}$  million, 22 million in all.

The majority of these maps were of Burma and eastern India but long range production was commencing, particularly in respect of Siam and Malaya on topographical scales, and in the introduction of a new series on 1/500,000 scale designed as an air approach map and the introduction of a new arrangement ( the “Ground Air” later called “Army Air” ) of the International 1/M map of which a specimen is included in the pocket at the end of this book. Reversion to full colour publication policy was now pretty well complete and, as pre-war, colour separation was increasingly becoming a problem that had to be met by considerable expansion in the negative retouching and zinc correcting sections of the publication offices.

The maps of Siam referred to were a large number of  $\frac{1}{4}$ -inch, the whole of the Siam series on this scale, that had to be reproduced in colours from the single copy ( often badly printed ) of each sheet that was available to us ; this was a tiresome task that took a long time

and called for the exercise of considerable ingenuity on the part of the publication offices, and close collaboration with the drawing offices.

Fortunately, we were relieved early in 1943 of almost all the remainder of Irān ( para 88 ), Mid-east assuming map responsibility as far east as longitude  $60^{\circ}$  ; the Frontier Circle was looking after the requirements of North-west Army, so the remainder of the Department and the military offices could concentrate on the east. Ceylon published most of its own maps though we held material for emergencies.

**116. Drawing.**—The new series mentioned in the preceding paragraph naturally entailed a great deal of drawing work as well as publication work. Drawing in connection with publication allotted to Calcutta was normally carried out by No. 1 Drawing Office there ; that for work allotted to Dehra Dūn, including Hāthibarkala factory, normally by the Eastern Circle which had become almost wholly a drawing circle and which utilized also most of the power of No. 2 D.O. of the Geodetic Branch. Later on, a drawing office was established in Hāthibarkala as well.

Since many maps of India ( and Burma ) were not gridded ( para 33 ), a very great deal of drawing and lettering work was necessary to apply grids to the existing maps of eastern India and Burma, apart from that required for new series. Some saving of time was made by the use of “master grids” and more by the teaching of the practically lost art of hand-lettering in lieu of the much slower hand-typing ( para 113 ). Training in hand-lettering was also carried out in the field training units at Abbottābād and surveyors from these units were often employed on drawing in Dehra Dūn while awaiting posting orders in the Survey Depot. The Depot was moved to Dehra Dūn in 1943 and its establishment of reinforcements provided a very valuable addition to drawing and publication personnel available there.

Large numbers of draftsmen were recruited for trial ; they were put on simple productive work after three months practice ( or discharged as the case might be ) and usually became quite competent draftsmen after one year. With the mobilization of more and more experienced officers, however, the problem became one of inspection for accuracy ; quick and thorough “examination” of a map takes much skill and experience. Maps could not be held up indefinitely for examination and consequently, as might be expected, quality fell off both in accuracy and standardization.

**117.** The quality of drawing materials had also fallen off considerably. Best quality drawing paper, pencils, drawing inks, water colours, etc., were not used to any great extent in India except by the Department and were not manufactured in India. The Stationery Department did its best to meet our much increased requirements of such technical stationery and of a material much used for air survey work known as “kodatrace” but it became evident that we must have more direct access to sources of supply to carry out our

work efficiently and, particularly, to supply military survey units based on our Stores Organization. Arrangements were therefore made that the War Office in London would supply such materials direct to the Survey of India Stores Office, on indent by the D. Svy. ( India ) ; this arrangement was soon after extended to cover all survey and mapping stores that had to be imported from Britain or the U.S.A. We thus received military priority on such stores both in respect of supply and sea transport while at the same time having our priorities controlled by the organization that best knew the manufacturing situation and the operational needs of each war theatre, the War Office.

**118. Stores.**—The Stores Office by this time occupied several hired buildings in Dehra Dūn and now handled technical stores of all types, including technical stationery, except ordinary office stationery which was supplied direct to units from the Stationery Department and Survey of India technical forms ( used also by the military units ) and office forms supplied direct by the Geodetic Branch ; later, these forms also were stock-piled by the Stores Office.

The G.S.G.S. submitted indents on the War Office for imported stores, dealing with them direct ; the Stores Officer submitted indents on behalf of the Surveyor General on the Supply Department for local stores, in the case of instruments however, corresponding direct with the Mathematical Instrument Office in matters relating to type and design, quality and inspection ; direct local purchase was permitted in emergency, for example when printing inks happened to be in short supply and we heard of a local firm having received a quota. We were fortunate at this time in obtaining the services of a civilian officer of wide business experience ( Stewart ) who had been evacuated from Burma, to take charge of this greatly expanded organization.

**119. Mathematical Instrument Office.**—Though this office had been transferred to the Department of Supply in 1941 ( para 73 ), it continued to be our main source of supply for instruments and to advise on design and inspect and assess quality in the case of a good number of drawing instruments like dividers, ruling pens, scales and simpler surveying instruments like Abney levels whose manufacture had been delegated by the M.I.O. to the trade in India.

The M.I.O. was now concentrating mainly on the manufacture in quantity of a limited number of instruments in general use throughout the army such as binoculars, prismatic compasses, certain gun sights, etc., and a new factory at Raipur ( near Dehra Dūn ) was coming into production for this purpose with the object of taking over the majority of mass production while the old Calcutta M.I.O. would continue to manufacture the smaller quantities required of more diversified lines. A large organization for the calibration and repair of aircraft instruments had also been established by the M.I.O. in Calcutta.

**120. Scientific work.**—For operations eastwards, a large volume of technical data was required pertaining to Siam, French Indo-China, Malaya and the Netherland East Indies, not hitherto associated with India. This involved much research in respect of triangulation, magnetic values, etc., with attendant computations to co-ordinate and record them in terms consistent with India and Burma data, mutually consistent.

Until 1943, scientific work was mainly confined to computations connected with the adjustment of 'Irāq-Irān triangulations, converting geographical co-ordinates to grid co-ordinates in eastern India and Burma and the routine prediction of tides for the preparation of tide tables for some 40 ports in the Indian Ocean, Arabian Sea and Bay of Bengal; from Suez to Singapore. As a safeguard, we had started in 1942 to predict tides much farther ahead; ours was the only tide-predicting machine in Allied hands east of Britain and though the bombing of Dehra Dūn was unlikely there was always that possibility, or the possibility of sabotage.

**121.** It was opportune that in the early part of 1943 Dr. J. de Graaf Hunter, sc.D., C.I.E., F.R.S., joined us. He had been in charge of the Computing Office and later Director, Geodetic Branch from 1928 to 1932 and had volunteered to rejoin the Department in 1941. Unfortunately his ship was torpedoed and he had been a prisoner in Germany for some time; he was released late in 1942 and reached India via Damascus and Basra, taking over a new post of Assistant Surveyor General ( Technical ) on arrival in Delhi.



## CHAPTER IX

### WAR, 1943-1944

**122. Reorganizations.**—The arrival of Dr. Hunter in India coincided with the rising trend of demands on the Survey of India for trigonometrical and other scientific data, as the army reorganized to cope with the Japanese threat to India's eastern borders and coast-line and for its ultimate forward movement.

At the same time, administrative work in the Geodetic Branch greatly increased due to the considerable numbers of Survey of India personnel in Dehra Dūn ; though there were actually three independent circles there ( Map Publication, Eastern Circle and Geodetic Branch ) the last named had been there for many years and was usually consulted by local authorities on all matters pertaining to the Department ; map publication and drawing work had also increased greatly in this Branch, and a large amount of building work was involved in its expansion, the construction of barracks for the B.O.R. Cadre ( para 112 ) and other special construction works in its compound ; its cantonment party was now of very sizable proportions and scattered all over India, and a new party, the Punjab Irrigation Party, had been formed to carry out an urgent survey for irrigation in connection with the "Grow More Food" campaign and the rehabilitation of returned soldiers.

For some time I had been trying to separate out administration for the whole of Dehra Dūn into a separate administrative circle, or under a Deputy Surveyor General representing the S.G. in Dehra Dūn, but the difficulties were too formidable—experienced clerical staff was very short and was "dual purpose", the same clerks handling both administrative and technical correspondence.

It was therefore decided to relieve the Geodetic Branch of all scientific work by creating a new circle which was called the War Survey Research Institute ( "W.S.R.I." ) and of which Dr. Hunter was placed in charge. The Geodetic Branch retained its name, though now a misnomer ; to have altered it would have created much confusion. The G.B. clerks however dealt with all administration for the W.R.I. leaving the latter more free to concentrate on purely technical matters.

**123. Administration** was very heavy throughout the Department during this period. Rationing systems had been introduced in all provinces and in most of them some compensation was granted for higher cost of living, the Central Government having a separate scheme of its own. In our case this was awkward for we were constantly transferring men from one province to another to meet survey and training needs and to staff the Hāthibarkala map

factory ; rice eaters did not like wheat and vice versa and ration systems differed even from place to place in a single province. Extra rations allowed by some schemes to "manual workers" caused complications and the steady increase in cost of living resulted in more and more demands for increased pay ; clothing too was rationed and the systems differed in our various "Stations". All this threw a heavy burden on the Surveyor General's Office which had to be strengthened ( at the expense of the Circles ) and reorganized ; there were now separate Assistant Surveyor Generals for Administration and for Organization and Establishment ( Pushong, Verma ) and work was considerably decentralized.

The introduction of trade pay in the military survey units, while much easing our volunteering situation, caused heavy work both in the S.G.O. and the Military Circle in working out a suitable scheme and applying it retroactively. A number of schemes were put forward for the improvement of pay in the Department to meet the high cost of living and to bring emoluments more in line with those applying in the army.

124. The return of units from 'Irāq-Irān ( para 103 ) provided considerable military survey reinforcement to the 14th Army ( Colonel Bomford ) fighting on the north-east borders of India and to the Southern Army ( Colonel Angwin ) preparing defences on India's east coast and carrying out intensive military survey training. Some badly needed instructors ( para 105 ) were also made available to the Survey of India and some war experienced officers, including Colonel Heaney ( late D.D. Svy. Tenth Army ) who took charge of the Frontier Circle, until required for the post of Director of Survey, 11 Army group in February 1944.

125. With the formation of South-east Asia Command late in 1943 and 11 Army group, our military set-up altered considerably ; a number of new units were also formed partly from the Survey of India, partly from outside it, some on special new war establishments designed to meet military requirements in the light of experience in the European and Mid-east theatres. Except for supplying a considerable proportion of the personnel for these units and training them or giving refresher courses in ground and air surveys, the Survey of India as such had no concern with their formation this now being done entirely by the D. Svy. ( India ) through the Survey Depot. Men awaiting posting to the new units or as reinforcements to old were loaned by the Depot to drawing and publication offices in Dehra Dūn for productive work.

The Depot was now recruiting "class IV servants" ( I.O.R.'s ) direct instead of through the Department as at the outset of the war, and was giving them the necessary training in chaining, heliotrope work, etc. With heavy army recruitment in the Punjab and Garh-wāl and Kumaun, whence many of our class IV servants ( khalāsīs ) came, the Survey of India was now relying mainly on Ooriyas from Bihār for its khalāsīs and these would usually not volunteer for military service.

126. On 31st July 1944, military survey strength was considerably increased compared with 1943 ( para 110 ) and besides the Officer, V.C.O./Havildar and B.O.R cadres ( now 107 strong ) consisted of two separate groups under the control of the D. Svy. ( India ) and D. Svy. 11 Army Group, respectively, the latter dealing through the D. Svy. ( India ) in respect of reinforcements and other personnel questions.

<i>Director of Survey ( India ) ( Including Southern Army )</i>	<i>Director of Survey, 11 Army Group</i>
G.S.G.S. ( Delhi )	Army Group Survey Directorate
Survey Depot ( Dehra Dūn )	1 Army Survey Directorate
1 Army Survey Directorate	2 Corps Survey Directorates
2 Command Survey Directorates	1 Air Survey Directorate
3 Field Survey Companies	2 Field Survey Companies
3 Mobile Reproduction Groups	2 Air Survey Companies
1 Base Reproduction Section	2 Mobile Reproduction Groups
2 Map Supply Sections	1 Base Reproduction Section
1 Survey Park Section	5 Map Supply Sections
1 Base Map Depot ( Central Map Depot, Delhi )	1 Survey Park Section
	1 Air Survey Liaison Section

127. The movement forward of the two Air Survey Companies ( Nos. 5 and 7 ) occurred about the same time that demands on the Survey of India for civil survey works connected with "Grow More Food" and reconstruction plans, mostly for irrigation projects, became very heavy. I had up to then been dealing personally with correspondence about these steadily increasing demands, my office keeping up "rosters" on which priorities could be assessed; no projects had been taken up though many were of great urgency, to produce more food and also more electric power which was becoming very short.

A post of Projects Officer was therefore created from 1st April 1944, with headquarters at Dehra Dūn, and again the unfortunate Geodetic Branch had to help out with administration. It was essential that the post be filled by a senior officer of wide experience with good knowledge of air survey and Colonel Crone was reverted to civil employ, continuing also to fill the post of Air Survey Officer, Survey of India ( para 109 ) in addition. At the outset, the intention was to go no farther than recording demands for works, estimating for them and completing preliminary organization in order of priority, works to be taken up later on as staff became available. The great need for short term irrigation projects, however, made it necessary to start some of the more urgent works at once and by the

middle of 1944 two of same size were in hand with such personnel as we could scrape together, a scheme for damming the Rihand river in South-east U.P. and a similar scheme near Dehra Dūn in the Tons and Giri river watersheds.

To save personnel, air methods were required to be used as much as possible and during the course of this summer Messrs. I.A.S.T. took photographs under their charter with us covering about 3,000 sq. miles of country.

Young officers under training were utilized for most of the ground work which, as in the case of the Hazāra Detachment, provided excellent advanced training ( para 94 ) in theodolite work and expedients designed to save manpower.

128. War works.—Messrs. I.A.S.T. also took a large quantity of air photographs both vertical and oblique for military purposes in the twelve months ending 31st July 1944, the greater part of which was for the production of maps of airfields, reservoirs, bridge protection, etc., and included an area of some 4,000 sq. miles for North-west Army.

It was not possible to operate these light aircraft ( Moths ) close to the battle front or in very high areas, their ceiling being only about 18,000 feet, but they were able to cope entirely adequately with most areas of which photos were required.

129. Most of the actual air survey work for military purposes during this period was carried out by the various Field and Air Survey Companies ; No. 18 Party did undertake a few tasks like artillery practice range maps and target maps but in the main concentrated on training and a few small civil jobs. Altogether, 112 officers and other ranks of the Survey of India had been trained since August 1st 1943 or were under training on July 31st, 1944 in addition to special courses held for 72 officers and men of the Royal Artillery and 17 of the Royal Engineers.

Two "Slotted Templet" sets were obtained on lease from the Fairchild Corporation of America in 1943 and as far as possible officers were trained in the use of this ingenious device which greatly expedited, by mechanical means, one of the most troublesome stages of air survey by the radial line method. These sets were lent to the military survey service in 1944 and were eventually returned to America when the British counterpart, the "Slotted Template", became available.

An American Topographical Battalion was established near Dehra Dūn late in 1943 and their air survey equipment was looked on with some envy by our air survey personnel though as already mentioned, it had been our policy throughout to adhere to the simplest possible methods of making a topographical map so that the greater number might master the technique.

130. There was little topographical survey work done by the Survey of India during this period. The military survey units did carry out some ground survey, but the majority of their work was from air photographs.

Both services had many large scale ground surveys to make for airfields, camps, depots and the like, No. 20 Party carrying out most of the work done by the Department under the technical control of the military D.D. Svy. where there was one, otherwise as directed by the Chief Engineers of Commands and technically controlled by the Director, Geodetic Branch.

Because this unit was working in very small detachments, requiring a high proportion of men competent to work independently it was difficult to keep pace with its constantly expanding programmes ; by 1944, however, some of our older surveyors began to come back from the military units and provided welcome reinforcement either directly to 20 Party or by relieving still older men in the Surveyors' Training Party at Abbottābād.

131. Ground training in the Abbottābād area had by now become well standardized, with a number of officers who had served in 'Irāq-Irān assisting in its direction (para 124). The addition in the Surveyors' Party of an administrative section ( para 105 ) under a military officer did much to relieve the O.C. and also the O.C. Officers' Training Party of military administration, leaving them more free to organize the technical side of the work and suitable recreation activities like hockey, cricket and football.

Training in drawing work continued to be distributed about the various offices of the Department, though mainly in the Eastern Circle, and similarly in map publication work, the British Officers and B.O.R.'s of the attached cadres being invaluable in training our personnel in the use of modern high speed machinery apart from actually operating these machines.

132. Map publication in 1943-44 was relatively light ( about half that of the preceding year ) only about 11 million maps being published as against 21 million the year before. This was partly due to the military units in 14th Army and Southern Army being sufficiently well established to look after their own tactical maps almost entirely, publishing between them about 6 million maps while the G.S.G.S. organization published another  $\frac{3}{4}$  million, but was mainly due to the "marking time" that occurred while the issue on India's eastern borders was in doubt and plans for forward movement were being completed.

The Survey of India publication during this year was very diversified including, apart from India itself, maps of Irān, Afghānistān, Burma, Ceylon, Siam, Indo-China, Malaya, Sumatra, U.S.S.R., China and Japan ( with guide maps of Tokyo ) but quantities were not so great as hitherto and there was something of a "wait and see" policy. This was greatly to our advantage for it gave us time to get thoroughly organized for the rush of work that was soon to come and to get well stocked with papers, inks, etc., and generally put our house in order, before the forward move.

133. Though actual publication was comparatively light, a minimum four-colour policy had been permanently adopted and

some maps were published in more colours than four. This, together with the gridding of many maps of India that had not previously been gridded (para 116) entailed a good deal of extra drawing work in preparing grid drawings and various layer drawings and the extra drawings required for multiple colour reproduction. We were also busy on recasting maps of Indo-China and other countries of which maps were published with symbols not usually familiar to British and Indian troops and with names in foreign languages. Drawing work thus continued to be very heavy, carried out by the Eastern Circle and No. 2 D.O. ( G.B. ) in Dehra Dūn, No. 1 D.O. in Calcutta and a newly transferred drawing office in Hāthibarkala, No. 6, that had previously been the Frontier Circle Drawing office at Simla. Frontier Circle work at this time was dealt with by "A/E" Party at Murree, which was, in effect, a drawing office as was the whole of Eastern Circle in Dehra Dūn.

Projects work and scientific work added to the volume of drawing and publication work ; the latter particularly, in respect of triangulation charts, magnetic diagrams, etc., and in the letterpress section, tide-tables. A revised edition of the Survey Service Pocket Book ( para 69 ) was also published in 1943.

134. Work by the War Survey Research Institute was almost entirely for military purposes. Tides were predicted up to 1947 and published for 1944 and 1945 for the usual 40 or so ports, plus 27 or 28 ports extra for 1944 and 1945, to cover possible military landing areas in Burma and Malaya. Special tables were prepared to indicate the height of water at *any* time for about 47 places in the same area ; these necessitated a specially designed addition to the tide predicting machine.

"Moonlight diagrams", indicating the times of brightest light and darkest night were assembled for 1944 and ( to offset shortages in nautical almanacs ) special almanacs indicating the position of nearly 400 larger magnitude stars were computed and published. Much trigonometrical data in the eastern India-Burma area was assembled and published in Lambert Grid terms, as well as preparation for the publication of such data in Indo-China and Sumatra, China and Netherlands East Indies.

No field work was done except the very urgently necessary re-observation of magnetic data at 25 stations, mostly in eastern India. The results were incorporated in revised magnetic charts which were now in consonance with Admiralty Charts and Australian data. The Survey of India had done almost no repeat field observations for magnetic data for many years and our information was at variance with more recent Admiralty and Australian information, which the 1943-44 observations corrected and reconciled.

Research was also carried out in astro-fix methods mainly for the use of survey troops in their forward advance but also with an eye to their peace time use in controlling isolated surveys for irrigation and similar reconstruction and rehabilitation projects.

## CHAPTER X

### WAR AND EARLY RECONSTRUCTION, 1944-1945

135. **Military reorganization.**—The formation of a survey directorate with headquarters 11 Army Group ( Brigadier Heaney ) has been mentioned ( para 124 ) ; this directorate expanded during 1944 to become the main survey directorate in South-east Asia Command though it actually worked with Headquarters Allied Land Forces, S.E.A.C. ( ALF SEA ). A survey staff directorate ( Colonel Collins ) was also formed at the Headquarters of the Supreme Allied Commander, S.E.A.C. ( SAC SEA ) in Kandy, Ceylon whose function was to interpret the military situation as it affected survey and map work and keep D. Svy. ALF SEA informed ; it also undertook such drawing and map publication work as was required to be done on the spot at H.Q. SAC SEA.

Before the end of the year, most of the survey troops that had been under the control of D. Svy. India ( para 126 ) were transferred to the control of D. Svy. ALF SEA and some additional units were raised or transferred from other theatres, including the West African Field Survey Company.

136. The formation of these new headquarters and the transfer of survey units away from India left the G.S.G.S. ( India ), and the Survey of India, performing base rôles very similar in character to those performed by the G.S.G.S. ( War Office ) and the Ordnance Survey of Britain.

Demands on the War Office and the Survey of India from D. Svy. ALF SEA were normally passed through D. Svy. India who controlled reinforcement pools and acted for the Surveyor General in controlling map publication demands ( para 95 ) ; similarly demands by the Survey of India on the War Office for survey stores passed through D. Svy. India.

Early in 1945 small directorates under the charge of an Assistant Director of Survey were set up at the headquarters of military Commands in India, under the control of D. Svy. India, to filter map and survey demands on the G.S.G.S. ( India ) and the Survey of India ; these directorates formed the starting point of a post-war decentralized military survey staff system, co-ordinated by the Director of Survey ( India ) at General Headquarters.

The D. Svy. India ( Brigadier Glennie ) visited the War Office in 1944 to discuss these arrangements and in January 1945 the D. Svy. War Office ( Brigadier Hotine ) visited India.

137. By the latter part of 1944, routine was well established in the Base Organization in India for the prosecution of the war

eastwards ; military and civil rôles were well integrated, we had tremendous map publication power at disposal and training and survey stores procedures were working smoothly.

138. **Rehabilitation and repatriation programmes.**—These introduced complicating factors in the smooth running of our war machine.

A considerable number of our attached officers and B.O.R.'s ( map publication technicians ) were nearing their time for repatriation to Britain ( PYTHON ) or for leave in lieu ( LILOP ) ; practically all our own British officers had done more than their time abroad under the repatriation scheme and though it was a moot point whether they were eligible under the scheme, there was plenty of correspondence about it ; and the necessity for finding replacements whether they were repatriated, went on military LILOP leave or on civil "key" leave ( introduced during this period to permit the recuperation out of India of officers required for earliest post-war reconstruction ) caused a good deal of hard thinking that might otherwise have been applied to war problems.

139. The Government of India was also considering seriously how its services would be built up after the war and what would constitute prior claim to appointment in its services on a permanent basis ; there were various questionnaires and schemes that had to be thrashed out in the Department, all causing time to be taken out from war work, necessary though this of course was. I felt quite sure myself that ( in view of the many demands we had had for works ) there would be ample work at least for some years to employ everyone we had in service early in 1945, both military and civil, if they wished to be so employed. I also felt that we could not afford to sacrifice the time and money that had been spent on training the officers and men now in the Department or the military survey units by permitting them to be ousted by non-survey personnel from other military services, who would have to be trained from scratch just at the time we could least afford personnel to train them.

As a matter of departmental policy I therefore pressed on every possible occasion for post-war expansion compared with 1939 and resisted all proposals to oust trained men by untrained men. Once having decided on this departmental policy I took every opportunity that arose—and they were many—to point out that *survey* work must precede works of whatever sort and hence when peace did come we must be a well-trained and strong Department. Otherwise, post-war works would fail or be much delayed.

140. Included in the Government of India plans for rehabilitation was the settlement of deserving members of the military forces on newly developed land and employment on public works like irrigation, flood control, hydro-electric and similar long term schemes. To be of use immediately war ended, such schemes would have to be in a reasonably advanced state of organization when



military personnel began to be demobilized from the military occupation and reconstruction forces outside India. This obviously meant that preliminary surveys must be undertaken during the currency of the war, in addition to those required in connection with the immediate short term "Grow More Food" plan ( para 122 ).

Our problem was to find the personnel. Though the Department had increased in strength from 1,400 (excluding khalāsīs, etc.) before the war to about 2,900 in early 1945, some 700 were in military units and these were naturally many of our most skilled men. Of the remainder, considerably more than half were map publication personnel, draftsmen, computers, clerical staff and trainees; we had very little experienced field personnel available, for the majority of those we had were employed either on supervision, as instructors or in No. 20 (Cantonments) Party, still heavily engaged on surveys for military airfields, depots and the like. Priorities of rehabilitation works had therefore to be very carefully considered both *inter se* and as between war work and post-war reconstruction.

141. Instruments also were short, particularly theodolites and levels; the military survey units had to have the best and lightest instruments and in the Department we had only a few of these, used primarily in the training units. On the other hand, the Public Works Departments, Railways and Military Engineering Service were asking for increasing numbers of the simpler types of instruments for their preliminary reconstruction surveys.

Burma, too, was beginning to plan for the future and having of course lost all its instruments during the Japanese invasion, was making requests on India for supplies to be earmarked for them. A plan for a post-war Survey of Burma had been drawn up by us and tentatively accepted by the Government of Burma, then functioning in nucleus in Simla.

Towards the end of 1944, a conference with the military Civil Affairs Service, Burma ( C.A.S.B. ) resulted in outline plans being drawn up for works to be done in Burma by the military survey units, pending taking over by the civil Survey of Burma. As soon as possible, search was made for the records left in Burma ( para 86 ) but no trace could be found. They would therefore have to start afresh with detailed traverse and triangulation; geodetic records of course existed in the Geodetic Branch at Dehra Dūn but unfortunately practically all topographical records had been transferred to Burma not long before the war.

Before the end of 1944, however, a policy was settled for the division of instruments between civil and military and what could be spared for Burma and it was arranged with the Disposals Directorate, formed in 1945, that all high precision instruments would be returned to the Survey of India when demobilization commenced, the simpler instruments being allotted to the various engineering services. A number of precision instruments were also put on order in Britain, through the War Office.

142. **Reconstruction works.**—For the reasons just discussed—shortage of trained personnel and instruments—we could not proceed very fast with reconstruction surveys during 1944-45; however, by making use of trainees and every device we could think of to get quick results of acceptable accuracy with minimum use of precision instruments on the ground, implying a maximum use of air photographs, we did manage to get ahead with a number of the most urgent short term projects and to lay the foundations for some of the bigger projects of a long term nature. One innovation that saved much time was the use of air photo mosaics, contoured from clinometer and barometer heights on the ground, for the assessment of the volume of water to be impounded by proposed dams. ( See *Projects* ).

143. Works in hand during 1944-45 were practically all reservoir projects for increasing food and/or power production; they included the Rihand and Tons-Giri projects mentioned ( para 127 ) and similar works in the Chenāb and Sutlej valleys, eight reservoirs in Rājputāna and Jodhpur State and two in the northern part of the U.P. Only one work, the Nayyar reservoir in U.P., was fully completed before VE day.

All these works required air photography by Messrs. I.A.S.T. under the charter with them, which had been renewed annually since its inception in 1942 ( para 98 ) ; this firm also photographed about 2,500 sq. miles for military purposes during this period and a considerable area in the Bālipāra Tract in north-east Assam.

144. **Other civil works.**—The survey of part of the Bālipāra Frontier Tract was asked for by the Political Department of the Government of India to provide topographical maps of a large and hitherto practically unmapped area in the eastern Himālaya. The area was mostly high ground and weather was usually bad over it, close to the Assam-China “Hump” as it was; our small aircraft could not make much headway in its photography and we tried many times to obtain one high ceiling service aircraft such as a Liberator bomber to do this job for us, without success. Little progress was therefore made during this season, and indeed thereafter up to 1946. Some R.A.F. Hurricanes were sent to the area but made little progress in its photography not being suitable for the purpose.

145. The International Air Convention in Chicago in 1944 brought some heavy work in its train early in 1945, in connection with the design of civil aviation aeronautical charts to be adopted internationally; India agreed to conform to international regulations but we were not happy about the proposals not only because the arrangement of the charts themselves put India at a disadvantage but also because they implied a new basic series of maps that could not be directly related to any existing series, getting us back to just what we were trying to avoid before the war—multiple series of maps with attendant high cost or in the alternative, failure to keep all series up-to-date ( para 36 ).

146. The field work of the Punjab Irrigation Party ( para 122 ) was completed early in 1945 and that of the Hazāra Settlement Detachment early in 1944 ; in its place however another detachment was formed late in 1944 to carry out similar work in the Kulu district of the Punjab. Like the Hazāra Detachment, the Kulu Detachment was used to provide advanced training in theodolite work for trainees, both during and after the war.

Early in 1945 the Projects Officer ( Crone ) went to Kābul to look over a Wild A 5 Autograph possessed by the Government of Afghānistān and offered to us on loan in return for India undertaking the survey training of a number of engineer officers of the Afghān army, who had joined our officers' training party somewhat earlier.

147. War works.—Training continued in the units of the Frontier Circle at Abbottābād and Murree on the lines more or less standardized in 1943, revised as necessary to meet latest military requirements. The Afghān officers ( fourteen ) were started on their courses ( from six months to two years ) in the field and three Chinese officers were also given instruction in various survey duties. About 250 officers and other ranks received field training and over 100 air training, besides about 80 British officers and other ranks who attended air survey courses in No. 18 Party.

In anticipation of heavy reconstruction demands, a large number of men were also under training in levelling, traversing, drawing and computing, in various units of the Survey of India.

148. Little air survey work was done in the Department during 1944-45 except in connection with training and ( a very small quantity ) in the Projects Circle whose work was aimed at high quality surveys of limited areas, the Bālipāra Frontier Tract ( para 144 ) being the only air survey of a topographical nature undertaken.

The military survey units in South-east Asia Command carried out a great quantity of air survey work for the advance eastwards, most of which was published by their own publication units.

149. Map publication was very heavy both in the military units and the Survey of India ; up to VJ day, the former had published over 24 million maps, mostly in SEAC, and the latter over 22 million, since 1st August 1944. Nearly all maps were now being published in at least three colours with the majority in four or even more ; the total number of impressions taken to provide the 22 million maps supplied by the Survey of India was over 108 million.

In general, the forward units dealt with their own tactical maps and others very urgently required, the Survey of India helping out in emergency but dealing mainly with strategical maps and long-term programmes ; maps published were of India, Burma, Siam, Indo-China, Malaya, Netherlands East Indies, China and Japan,

150. The organization of publication of such a large quantity of maps of so many parts of Asia, on a variety of scales and layouts and with constantly altering priorities, was a heavy and complicated task. Additional posts of Chief Draftsman and Assistant Director, Map Publication had been created earlier ( para 70 ) to assist the D.M.P. in this work but in 1944 it became evident that one director could not competently handle *both* organization and publication and consequently a new Director's post was created, called Director, Planning Maps, commonly abbreviated to D.P.M., the name being selected merely to distinguish clearly between D.M.P. and the D.P.M.—whose sole task was to organize publication work and priorities, the D.M.P. as hitherto directing actual publication ; in effect, the previous responsibility of the Director, Map Publication was now divided between him and the D.P.M., the latter also being provided with a suitable staff of Assistant Directors and Chief Draftsmen.

Routine liaison visits by the D. Svy. or a representative of the G.S.G.S. from Delhi helped to reduce correspondence and keep priorities correctly assessed.

151. Colonel Penney, D.M.P. from 1941 in Calcutta and in Hāthibarkala from 1943, was reverted to the Home Establishment in 1944 due to ill health and was succeeded as D.M.P. by Colonel Gemmell ( D.D.M.P. since 1941 ) who remained in that post or the new post of D.P.M. for the remainder of the war and during the early reconstruction period. The headquarters of both D.M.P. and D.P.M. being in Hāthibarkala, a Deputy Director was in charge of the Calcutta offices though these were of the same or even larger size than before the war, except for the Map Record and Issue Office having been transferred to Hāthibarkala (in 1944) both to concentrate our maps in Dehra Dūn and to make room, in Calcutta, for a large military map depot under the control of the D. Svy. The tearing down of all the old map racks, transport to Dehra Dūn re-erection there, was a big task.

152. The Hāthibarkalā factory, the only big publication office operated by the Survey of India that was specifically designed for the job, was in full production by the end of 1944 and—though the buildings were only of a semi-permanent nature—was an exceptionally well organized and arranged publication plant, probably one of the best in Allied hands, for which great credit is due to the original designers Crone and Penney and the main organizer Gemmell.

Though residential buildings ( temporary construction only ) left something to be desired, the publication and drawing offices were first class and—despite some argument as between Gemmell and myself about the necessity for providing ceilings in the work buildings—were fairly comfortable to work in even during the hottest weather because of their height ; the architect of the Central Public Works Department had made no mistake in building them with plenty of headroom. Only one thing remained to make these

offices very nearly self contained under any circumstances—an alternative source of electric power in case of failure of the hydro-electric system supplying Dehra Dūn. A diesel-electric power plant had been on order for many months.

Very considerable storage space both for paper and finished maps had been incorporated in the project but even so, it was necessary to get rid of published maps quickly during the rush of 1944-45. The 22 million maps published by the Survey of India in that year represents about 750 tons of paper that had to be handled into paper store, from paper store to machine room, thence to map store and finally to map depots in Delhi and elsewhere; the machine room in Hāthibarkala, working at full power, could use about one ton of paper per hour.

153. By this time, however, we had a considerable fleet of motor transport, a small proportion owned by the Survey of India, the majority borrowed from the army in India or on the books of our Stores Office for use by military units, the latter including some very useful heavy lorries with trailers. Without this transport, it would have been impossible to handle the vast volume of paper, maps and survey stores of all types that had to be moved to and from the railway in Dehra Dūn and between Dehra Dūn and Delhi by road.

154. The Stores Organization (para 118) expanded very rapidly with the formation of SEAC and the influx of equipment and stores of all sorts in preparation for the move eastwards. Until 1944 in hired buildings in Dehra Dūn, 13 new buildings were constructed during 1944 in the compound of the Geodetic Branch to which movement of offices and stores was practically complete on VE. This was as well, for from VE onwards till long after VJ stores poured in—stores that had been shipped earlier to build up reserves for SEAC and, after VE, stores released by Mid-east to us and at sea when VJ occurred. The 13 buildings were soon overflowing, though it must be said that overflow would not have occurred except for the atom bomb, hastening VJ.

In 1941, soon after the Stores Office was opened, about 240 different items were under supply; in 1945, the Office listed some 3,500 major items besides many minor ones. It handled some 17 different types of lithographic printing machines of various sizes together with necessary spare parts, about 200 different chemicals and inks used in lithographic processes and many different types of surveying, drawing and mathematical instruments, paper and other technical stationery obtained from the Mathematical Instrument Office in Calcutta, the Titāgarh and other paper mills, the U.K. and the U.S.A.

To deal with shipments to and from India, it was necessary in 1944 to establish branch offices in Bombay and Calcutta, to expedite clearance and despatch respectively and in the case of Calcutta to deal with paper shipments direct from the Titāgarh mills to ALFSEA units.

155. Except for theodolites and levels ( para 141 ) we were in reasonably good shape in respect of surveying and mathematical instruments, nearly all of which were now manufactured in India either by the M.I.O. or the trade. We did, however, have to have one considerable shipment from U.S.A. of certain instruments and particularly of technical stationery like water colours, drawing inks, pencils, etc., to be sure that we had sufficient stocks to meet demands from SEAC; the Stores Organization was required to serve about 120 different units, civil and military, during 1945, and this implied holding a considerable stock of small, quickly expendable stores.

One important item that presented some difficulty was the acquisition of invar wire, or even first quality steel tapes, for the manufacture of Hunter Short Bases which were an essential part of a field survey unit's equipment to enable triangulation systems to be originated accurately from a very short measured base.

156. The Hunter Short Base had been designed by Dr. Hunter some years before the war for use primarily as a military survey instrument; about 90 yards in total length, it consisted of four steel or invar tapes hung in catenary from light supports one of which had a lever and weight to apply constant tension to the tape; tapes were calibrated periodically in the length standardization observatory of the Geodetic Branch ( now under the War Survey Research Institute ).

Besides its use as a short base from which to extend triangulation of considerable accuracy very quickly, the H.S.B. was a very valuable instrument for accurate traversing by subtense methods and was frequently so used during the war, notably in the geodetic connection between Irān and India across the Lūt Desert ( para 103 ) which was completed early in 1944 by a military detachment ( Captain P. A. Thomas, I.E. ) of Survey of India personnel returning to India from Paiforce.

During 1945, Dr. Hunter sought to extend the usefulness of this system to provide accurate yet rapid control for irrigation surveys by using a longer base with elevated supports and observation platforms so that observations could be made over the tops of sugarcane and similar high crops.

157. Considerable research was also carried out in the W.S.R.I. in connection with rapid astro-fix methods, required to establish position and bearing ( in conjunction with the H.S.B. for scale ) in originating surveys in occupied territory as the Allied advance eastwards continued, and also in methods for deducing beach gradients from air photographs of coast-lines likely to be the scene of amphibious operations.

For the same purpose, special tidal charts to indicate the height of water at any time, similar to those initiated in the previous year ( para 134 ), were published for 62 places additional to the regular tide-table ports, increased to 67 for 1946, of which 39 were predicted

by us ; preparation of tide-tables for 1947 was already in hand, and special predictions for 1946.

Star charts were also prepared applicable to the various probable operational areas, as well as star almanacs ; and a large volume of triangulation data was converted from spherical to grid terms and published in pamphlet form covering the Andaman and Nicobar Islands and parts of Siam, Malaya, Borneo and China, that for Japan being in hand. Triangulation "dossiers" were also supplied as a routine measure for each country likely to be occupied, Borneo being in hand in 1945. These gave all available information about the accepted spheroid on which triangulation was based, the triangulation itself and the accepted grid system.

158. Another magnetic repeat observation programme was carried out in 1944-45 further amplifying information obtained the preceding year ( para 134 ) and information disseminated in the form of isogonic charts ; in all magnetic operations we were handicapped by the loss of our base magnetic observatories, one being flooded in the very heavy monsoon of 1943 and both being rendered more or less unserviceable by heavy building in the Geodetic Branch compound, which of necessity had to be so close to the observatories as to vitiate observations.

159. The loss of direct access to the Mathematical Instrument Office after its transfer to the Department of Supply ( para 73 ) and its trend towards mass production of a small number of articles rather than diversified production was not seriously felt in the Department as a whole but was indeed felt in the War Survey Research Institute which had therefore to set up a miniature M.I.O. of its own for the calibration and repair of many instruments and the preparation of experimental models of various innovations. This section of the W.S.R.I. carried out many jobs in connection with war work during 1944-45, and shortly before VJ arrangements were put in hand to establish in Dehra Dūn a proper scientific workshop, under Survey of India control as the M.I.O. had been till 1941, to perform these essential tasks. Concurrently, steps were taken to revise the organization of the W.S.R.I. by the inclusion of scientific officers who had specialized in certain fields like magnetism and metrology and harmonics ( for tides ) and who, by their terms of service, could be made interchangeable with officers employed in the projected National Physical Laboratory of India.

## CHAPTER XI

### DEMOBILIZATION, RECONSTRUCTION AND REORGANIZATION, 1945-1946

160. VJ.—Victory in the Japanese war naturally altered our situation far more than victory in Europe. The latter required reorientation to look over one shoulder instead of both ; the former brought in its train the necessity for complete reorientation to meet demobilization, rehabilitation, reconstruction and drastic reorganizations. On the scientific side of the work, there was not great repercussion—tides had still to be predicted and tide-tables prepared for the benefit of commercial instead of war shipping ; magnetic work had still to continue for the benefit of peace-time users of maps ; standardization of lengths still remained an essential part of survey work ; and research, now how to get the best results in least time and for least money, must still continue. The W.S.R.I. therefore, apart from dropping its “W” and becoming the Survey Research Institute ( S.R.I. ), carried on with its duties though with altered objectives.

161. One of these objectives now became the establishment over India of a close network of precise data in respect of position, height, magnetic information and information about the force of gravity from which surveys of any sort might be started and on which they might be closed, whether required by geologists, engineers or topographical surveyors. This project we called the All-India Development Survey, or “AID” survey ; it aimed at establishing monuments between ten and twenty miles apart on which would be engraved the data mentioned and it was not expected to be excessively costly over and above the expense that must inevitably be incurred to establish connection with existing geodetic series, level lines and gravity network in order to start off the many reconstruction projects already mooted or even sanctioned for execution. The Survey Research Institute now began to devote considerable time to working out methods for achieving this objective, while at the same time furthering methods to expedite the provision of trigonometrical and height control for irrigation surveys at lowest cost, both in money and man-power.

162. For a long time after VJ, shortage of trained man-power remained a very serious obstacle to expeditious reconstruction. Though demobilization schemes had been promulgated in the late stages of the war, its unexpectedly early cessation left many details to be worked out for the re-absorption of soldiers in their civil occupations or in new occupations like reconstruction works ; so far as the Survey of India was concerned, the occupation forces



were wanting many surveys in the various occupied areas and, quite reasonably, wished to tidy up surveys in progress before releasing surveyors—and the majority of Survey of India personnel preferred to remain in the army because expansion had caused temporary promotions that gave them far higher status and pay than they could expect on reversion to Departmental employ. Furthermore, all wished to avail themselves of “war leave” ( para 166 ) before rejoining, even when they had been demobilized. The shortage most felt at this time, mid-1945, was in trained air surveyors ; even our Italian prisoners of war air surveyors, who had been doing good work on civil projects, were soon lost to us.

On the other hand the B.O.R. and British Officers’ cadres, composed as they were mostly of skilled technicians of the British lithographic trade, were soon agitating to be demobilized so as to get back to their jobs in U.K., far more remunerative than their army pay—and they feared that their places might be filled in their various civilian firms if they did not return quickly.

163. Map Publication fell off little, if at all, with VJ. We had in hand heavy programmes of 1/M and maps on similar strategic scales in the various occupied countries and the army wished these continued to completion and in addition a complete re-issue of the Indian  $\frac{1}{4}$ -inch series as a start towards the rehabilitation of Indian map series, sadly neglected during the war except in respect of maps on the extreme east border and coast, and for the surprinting of grids on previously ungridded maps ; this rehabilitation of the  $\frac{1}{4}$ -inch series was also suitable from the civil point of view, for we had had many demands for maps on this and larger scales in connection with reconstruction projects, in particular geological projects connected with coal, mica, manganese and other minerals. It was out of question at this time to take up any wholesale revisions of maps on the 1-inch scale, so the  $\frac{1}{4}$ -inch series was concentrated on first of all.

These programmes were sufficient to keep our publication offices full up, but towards the end of the war, and particularly from VJ onwards, there was some boredom among our British technicians ; so long as we were competing against difficulties in turning out map requirements there was interest, but as soon as all was working smoothly and particularly when *war* needs were no longer to be met, these men lost interest in what to them was a simple and dull task.

164. To relieve this boredom, the Hāthibarkala map factory had taken up, early in 1945, the lithographic reproduction in colours of covers and other illustrations for a number of publications issued by the Information and Broadcasting ( later Information and Arts ) Department of the Government of India which taxed the ingenuity of the British officers responsible for the innovation ( Captains Hodgkinson and Rowlands, R.E. ) and all staff employed on this work, of which there is an example in Plate VI.

Our Indian map publication personnel had been instructed in the methods for this work, requiring the highest excellence in the lithographer's art, and had done some very creditable reproductions entirely on their own, though supervised by Captains Rowlands (on the photographic side) and Hodgkinson (on the lithographic side).

We hoped that the Survey of India might continue to find outlet for its now very great publication power, while at the same time continuing to develop the highest lithographic excellence not usually associated with maps pure and simple, by continuing to publish these covers and illustrations for Government of India magazines during peace-time. Failing some such outlet, it appeared inevitable that much of our carefully trained personnel must be dispersed and much machinery either scrapped or placed on a care and maintenance basis.

165. For as long as the cadres of British technicians remained with us, training of map publication personnel by them was continued; our own staff gradually taking over again as they were demobilized. Training in field and air survey for military duties ceased abruptly with VJ and batches of soldier surveyors unlikely to be absorbed in the Department were returned to their regiments at once, the training parties switching to refresher courses in civil survey methods, particularly those connected with the rapid prosecution of irrigation and similar surveys on which also considerable experiment and research began, to discover the means of fulfilling post-war obligations with maximum speed and minimum cost to the country. The Projects Circle had by VJ been amalgamated with the Eastern Circle and, as the heavy drawing work on which the Eastern Circle had been engaged during the war began to become decentralized again, this circle began to undertake an increasing amount of field work in connection with reconstruction, much of which was in eastern India.

166. Demobilization and reorganization.—I have mentioned (paras 138-141) the preliminary plans for demobilization, repatriation and rehabilitation; with VJ these plans were speeded up but (para 162) it was a long time before we secured the demobilization and immediate availability after demobilization of our more experienced personnel. The introduction of *deferred* war leave and the sanction of a comprehensive pay revision scheme in January 1945, both long fought for, went some way to ameliorating our situation but even so men were reluctant to return, as also the army was reluctant to let them do, and comparatively few were available for the 1945-46 field season (para 162).

One complete unit, No. 3 Company (Major Ross, R.I.E.) was, however, available for work during this season and a certain number of individual officers and other ranks also got back by then. It was not till 1946-47 that we could really get organized for a full-power season.

167. Soldier surveyors, notwithstanding the much improved pay conditions, practically all turned down our offers of employment, though perhaps many were glad to accept them later on. At this time they still expected to be pensioned off or receive land grants. There was employment for some in the military survey service which it had been decided to continue as a permanent measure at least in nucleus. A number of schemes for this service were threshed out concurrently with schemes for the post-war organization of the Survey of India and the formation of a School of Military Engineering (S.M.E.) in which the Survey of India agreed to co-operate in respect of survey training of R.I.E. officers and in respect of an officer "tour" system not unlike that in Britain as between the Ordnance Survey and the other branches of the R.E.

168. After much study of probable works required over the next 20 years, a comprehensive scheme for the reorganization of the Department was put forward to the Government of India and this was sanctioned, about doubling its strength as compared with 1939 and introducing certain new posts like Deputy Directors, not in existence before the war but much used during the war; and also a post of Deputy Surveyor General.

We were less fortunate, however, in respect of our plan to utilize our great map publication potential to become the nursery for a fine lithographic trade in India while at the same time meeting Central Government needs for modern coloured illustrations in its publications and acting as a reserve of power for any future emergency; after much correspondence and effort including a large conference that indicated that many departments wanted help, this plan broke down, mainly on inter-departmental budget rocks; and we lost the services of those most competent to train our personnel in colour work, the British Officers and Other Ranks who were at the top of their trade in Britain but were willing to stay on for a year or so on contract to start the plan.

Up to the latter part of 1946, however, few of our own map publication personnel had had to be released, due to the continuing large demands for maps from the army in India and the occupation forces in Malaya, Siam and Indo-China.

169. In October 1945 a number of officers from SEAC returned to India, among them Brigadier Heaney, who worked for some time as *ex officio* Deputy Surveyor General before proceeding on leave; Colonel Angwin officially assumed the duties of the post in December. In April 1946, we lost the services of Colonel Crone and Dr. Hunter, and Colonel Bomford went directly on leave from SEAC. Brigadier Glennie was retired about the same time and handed over to Colonel Osmaston his duties as Director, Military Circle and Director of Survey (India) and head of the G.S.G.S. Colonel Jackson (Eastern Circle) had retired in 1944 and Colonel Slater (Geodetic Branch) left us in August 1946. Colonel Phillimore,

our A.D.M.C., retired for the second time in 1945 having done invaluable work in keeping personnel matters straight. See *Military Circle*.

Reorganizations had to take into account the loss of these senior officers and also the loss of a number of officers of O.C. Party and Assistant Director status, mostly re-employed civilian officers who had offered their services for the duration of the war, but including also one military officer who was appointed Director of Survey, Burma; and one or two others who had decided to revert to the British Establishment, or who continued to be employed indefinitely on military survey duty outside India.

There was also some loss in the more junior ranks of officers and men who wished to leave survey employ (which they were not allowed to do during the war without some very strong reason) to better their prospects. This was to some extent offset by others wishing to join the Department from the armed forces but naturally implied the replacement of trained by untrained personnel.

170. Field Season, 1945-46.—Notwithstanding the shortage and uncertainty about personnel and the shortage of many instruments (para 141) a considerable quantity of productive work was carried out in 1945-46 and a large amount of training for the full season of 1946-47 that was to follow.

Several projects were in train in the Damodar River valley in Bihār and Western Bengal which were mainly concerned with flood control, irrigation and power development; and there was also a huge factory project (fertilizer and by-products) at Sindri. No. 3 Company (Para 166) was deployed on some of these works, Survey of India personnel on others. Following our policy of conservation of man-power by utilizing air photos to the maximum, much of this work was based on photos taken by Messrs. Indian Air Survey and Transport Company Ltd. This Company also did a great deal of photography in connection with the huge projects designed to harness the Kosi, Tista and Mahānadi Rivers.

Irrigation, flood control and power projects usually consisted of three separate surveys and sometimes a fourth—large scale for the dam site, medium scale for the reservoir area and commanded area and in a few cases extensions of smaller scales into the catchment area; in projects such as Kosi, Tista and Mahānadi, the commanded areas were huge, running into many thousands of square miles and while the most urgent surveys were of course those of the reservoir area, mostly done by air methods and dam sites once the project as a whole had been sanctioned, the commanded area surveys were of such size as to take up to 10 years to complete, even with the expanded Department.

In all, 32 such surveys were in hand during 1945-46 of which 8 of the smallest had been completed by the end of March, 1946.

171. The Kulu settlement survey has been mentioned (para 146); this continued to serve as a training ground in theodolite

work for reconstruction projects as it had served, like the Hazāra survey before it, for training for the military survey units. Another settlement survey in Almora district of the United Provinces, utilizing air survey methods, had been in hand for some time as an experiment and this was completed this field season.

There were also several land reclamation and soil conservation works in hand and various surveys for railway crossings over rivers, erosion prevention problems and the like as well as a town planning survey for Delhi (asked for before the war, shelved) on lines not unlike that in progress in Lahore when the war started and finished in the early part of the war (para 12).

Surveys for geological (mineral assessment) projects totalled about 25,000 sq. miles on 2-inch and 4-inch scales—a huge area for such scales which, coupled with modern military requirements of tactical maps on 1/25,000 or such scales, led us to propose a general enlargement of tactical scales, hitherto 1-inch, for a number of areas in India.

In all, 55 different project surveys were in progress during this season added to which were special topographical surveys in three areas totalling about 1,400 sq. miles. No routine topographical programmes had yet been re-started; it seemed doubtful when such a programme could be started, for the various works mentioned above would add up to surveys covering a total of about 50,000 sq. miles on scales from 100 feet to an inch down to 1-inch scale. The great majority was to be on 2-inch and 4-inch scales. This was a formidable enough task in itself, but in addition there were very many more projects on our registers that had not yet even been estimated in cost.

172. For expeditious and reasonably cheap results it was essential to utilize air survey methods to the full. To this end, the charter with Messrs. Indian Air Survey and Transport Company Ltd., in force since 1942, was revised to meet the addition of new aircraft to their fleet and to the changed conditions of peace instead of war, throwing I.A.S.T. back on their own resources for photographic film, paper, etc., instead of those of the R.A.F. At the same time, photo negatives that had been loaned to the R.A.F. central library at New Delhi (para 98) were returned to their owners.

Training was also carried out in the Abbottābād area in the use of air photos in the commanded areas of irrigation and flood control projects and in methods that would make best use of the projected "AID" survey framework (para 161).

173. Summer, 1946.—During this summer, work continued at nearly as high a pressure as during the war, in preparation for the projected very heavy field season in 1946-47 implying heavy training programmes in both ground and air training units in the Frontier Circle and in the formation of new parties to meet the expanded size of the Department and its reoriented works outlook. Leave programmes were also heavy in preparation for the field

season ( during which leave is normally not permitted in the Department ), leaving us short-handed ; and stores disposal and accounting took up much time. The stores buildings in Dehra Dūn were badly cluttered up with the accumulation that occurred in 1945 ( para 154 ) of which little had been got rid of, and more and more stores poured in from units under demobilization ; by the end of the summer, however, disposal plans had more or less matured and the accumulation began to move out either on issue or sale, or on destruction as unserviceable.

174. Discussions with the Supply Department resulted in a workable scheme for a Survey of India controlled "M.I.O." at Dehra Dūn ( para 159 ) and the final handing over of the original M.I.O. to that Department of the Government of India.

175. I was fortunate in being able to present personally our case for revised and improved scales of pay to the Pay Commission on October 7th, accompanied by my successor Brigadier Heaney, and handed over my duties to him on October 17th when I proceeded on leave preparatory to retirement.

## CHAPTER XII

### CONCLUSION

176. A brief comparison between 1938-39 and 1945-45 in respect of major changes in organization, procedure and programmes of work, as well as some major statistics, may be a suitable conclusion to this chronological record of the war activities of the Survey of India. The departmental situation before the war has been outlined fairly fully in Chapters I to III ; the post-war situation cannot be dealt with in full, for it had not fully crystallized up to 1946 nor is there the same necessity to do so, having no direct bearing on the war—the pre-war situation on the other hand set the pattern that practically speaking *must* be followed unless we were to take time out from the war to carry out a complete reorganization, an upheaval which ( even if we had been permitted by Government to do it ) would have set us back many months in our war effort and might or might not have been more efficient in the end. It was too big a risk to take, short as we were of military officers and civilian personnel that could readily be militarized in a short space of time, and organized as we were to take military work in our stride, at least until it became of very large proportions.

177. At the outset of the war, there was no Geographical Section, General Staff, no military survey service and no military personnel in the Survey of India except 28 officers in civil employ on terms of service different from their confrères in army employ ; and a small number of “soldier surveyors” on the Indian Unattached List or on the recently created Reserve of Military Surveyors, who could be called up for military service by the Commander-in-Chief in India. There were also a few soldier surveyor trainees still on the books of their regiments ( in first period of training ) and the Department administered but strictly speaking did not “possess” a few British draughtsmen ( Army Section, No. 6 Drawing Office, Simla ) who were also on the Indian Unattached List. No military personnel was attached to the Department for duty.

178. On VJ day, 721 Survey of India officers and other ranks, excluding class IV servants, were on military duty in military survey formations and units in India and South-east Asia Command and 11 officers and 107 B.O.R.’s were attached to the Department for duty. A considerable number of others were under training in the Department, to provide reinforcement to the India and SEA Commands.

The military survey formation and units in these two commands then amounted to the following, *practically* all of which except

the West African Field Company contained a greater or less number of Survey of India personnel :—

The Directors of Survey, India and ALF SEA, both Survey of India officers.

The G.S.G.S. India and the Survey Directorates with ALF SEA and SAC SEA.

The Survey Depot India and the Draughtsmen Unit ( late Army Section, No. 6 Drawing Office ).

Two Army, three Corps and one Air Survey Directorates.

Six Field Survey and two Air Survey Companies with one additional Air Survey Section and four Air Liaison Sections.

One Map Reproduction Company, two Base Map Reproduction Sections and seven Mobile Reproduction Groups.

One Map Supply Company, two Base Map Depots and seven ( mobile ) Map Supply Sections.

Two Survey Park Sections.

179. Except for the West African Company, reinforcements for these units were mainly supplied through the Survey Depot ( India ), training and/or refresher courses being given by the Survey of India.

The Survey of India Stores Organization was responsible for their maintenance in all survey stores and equipment, including technical stationery.

180. In 1939, the only approximately whole time training unit in the Department was the Training School at Dehra Dūn, training up to eight or ten officers in elementary survey work every year, sometimes only every second year. In 1945, there were two large units, the Officers' and Surveyors' Training Parties ( Abbottābād ), whose time was devoted solely to training, as well as No. 18 ( Air Survey ) Party almost wholly devoted to training, the Kulu Settlement Detachment providing advanced training in theodolite work, No. 5 Drawing Office of the Eastern Circle wholly devoted to training draftsmen and the Survey Depot/Survey Training Centre, training all I.O.R.'s in chainmen, etc., duties. In addition, map publication trainees were in considerable numbers in all publication offices ( no special establishment had been set up for their training ) and draftsmen were also under training in all units as well as No. 5 D.O.

181. There was no whole time Stores Organization until 1941 when a small office was set up at Dehra Dūn, supplying about 240 different items. In 1945, the Organization had a total staff of 207, occupied thirteen large buildings ( with considerable overflow ) in Dehra Dūn with branch offices in Calcutta and Bombay and handled up to 10,000 different items of plant, equipment, instruments and stationery including a stock of about 2,500 tons of map printing paper. A lithographic roller re-covering plant was about to be installed. Stores handled during 1944-45 amounted to nearly 15,000 tons.



182. Map publication in 1938–39 amounted to about  $\frac{3}{4}$  million copies of 1,580 different maps, charts, etc. ; in 1944–45 about 22 million copies of 2,483 different maps and in 1945–46 much the same. This was additional to the 24 million published by military units.

Instead of 6 medium speed ( hand-feed ) rotary offset machines and 11 flatbed machines, there were 21 high speed ( automatic ) rotary offset machines ( of which 10 were two-colour ), 8 medium speed rotaries and 4 flatbeds. Instead of one fairly powerful publication plant at Calcutta with relatively tiny ones at Dehra Dūn, Risālpur and Quetta, there were three very powerful ones at Hāthi-barkala, Dehra Dūn ( Geodetic Branch ) and Calcutta and one ( more powerful than Dehra Dūn before the war ) at Murree.

The strength of map publication staff approximately doubled during the war and in 1945 there were over 100 British military personnel attached for duty making a total of over 700 engaged on this work.

183. Survey of India map series altered little in numbers and arrangement ; as decided in 1939–40, the 1/M I. & A.C. series was discontinued, replaced by the 1/M International series which by 1945 was in very good shape being one of the main war map requirements—called during the war “HIND 5000” because it was pre-eminently used as a war map—and was extended far beyond the boundaries of India and Burma from information made available from the War Office and elsewhere. The style of the map was altered for the better, particularly in the layered editions, though the “fineness” of it deteriorated, military users preferring a bolder type of draftsmanship and hence rapid readability ; that, however, can be corrected in later editions. The pre-war aeronautical edition ( surprinting air information ) seemed likely to be superseded by the air chart style introduced by the U.S.A. which we regarded as a pity—we thought that the international style could be well enough adapted for air charts to meet all needs without introducing an additional series on a quite different layout and arrangement.

A new series, the 1/500,000 air approach map, was started as a “HIND” series and covered, with very bold drawing, a large area of eastern India and eastwards to Burma, Siam and Malaya ; this would probably become a very useful peace-time map with some modification in drawing, and might well be extended to cover all India.

As decided in 1939–40 the  $\frac{1}{2}$ -inch series was virtually “scrapped” except where it replaced the 1-inch ; style and layout, as in the 1-inch and  $\frac{1}{4}$ -inch, remaining as pre-war. The 1-inch and ( in particular ) the  $\frac{1}{4}$ -inch remained our main topographical series and with little change except for reversion again to multiple colours ( para 37 ) and much extension of the gridded areas ; practically all these maps were to be gridded in 1945, only a small fraction in 1939.

The trend towards 1/25,000 scale as a tactical scale for many parts of India became pronounced towards the end of the war and

was definitely considered in framing reorganization proposals in 1946 and in map policy proposals ; pre-war, only a few such topographical maps existed though there were many on this scale of cities and their environs. With the steady development of India, much speeded up in 1945-46, it was evident that some scale larger than 1-inch would be necessary at least in many areas ; being a suitable scale for both army and geological use, the 1/25,000 seemed likely to come into prominence.

The 1/2M ( our smallest scale "series" map ) went through the war practically unaltered in style. It was a very satisfactory map at the outset, and remained so.

184. Small or non-existent topographical programmes gave us little scope for amending and modernizing topographical ground survey methods ; but experience with modern air methods, greatly developed during the war, and the acquisition of aircraft under our own control ( charter with Messrs. Indian Air Survey and Transport Company Ltd., from 1942 onwards ) gave great impetus to the use of air survey not only for the revision of existing out-of-date maps but also for the preparation of new maps at prices competitive with ground survey, now much enhanced in cost due to rises in pay scales and general costs. Perhaps the major innovation caused by the war was the introduction of photographic aircraft under the full control of the Survey of India as regards their work, even though not actually owned by the Department or administered by it.

Apart from the great increase in air survey and improvement in methods in that sphere—including the use of slotted templates and of the Wild Autograph owned by the Afghān Government—topographical survey procedure remained much as pre-war, using the same type of personnel and the same instruments. In brief, ground methods of topographical survey progressed little, through desuetude.

185. Methods for irrigation, settlement and other cadastral surveys, however, altered drastically. Shortage of instruments and fully trained personnel led to much research in expedients which would save ground time and money ; air photos were much more widely used not only to produce maps on all scales connected with this work but as contoured "maps" in themselves ( mosaics ) to determine reservoir volumes, etc. Technique in this respect advanced very considerably ; barometers and clinometers replaced spirit-levels and theodolites in the provision of height control for contouring ( with accuracy very closely approximating that attained by the more precise instruments as used before the war ) and young and relatively untrained personnel replaced much more experienced personnel with little, if any, loss in accuracy though perhaps with some in speed.

It had been customary to initiate control for this type of local survey by breaking down the nearest geodetic triangle side, often 40 miles or more in length, from which position, azimuth and

scale were derived. This was a tiresome and costly business for not only were series sometimes far away, but to break down from 40 miles to say one mile involved a lot of triangulation and the weather conditions sometimes precluded visibility over 40 miles for weeks at a time.

Thanks to war improvements in Hunter Short Base and astro-fix technique, we were able to adopt the method of purely local initiation of triangulation, with subsequent connection, as opportunity offered, to precision work. In these circumstances, scale from the H.S.B. was accepted (with additional check bases at suitable intervals) and correction was made, if necessary, to azimuth and position from the subsequent geodetic connection.

In fact, we adopted for reconstruction surveys very much the same procedure that had been in vogue for some years for initiating military, particularly artillery, surveys—sometimes euphemistically called an “arbitrary grid”. In a number of surveys so initiated, we found very little adjustment to be necessary when connection to the geodetic triangulation was actually made.

186. The All-India Development ( “AID” ) survey ( para 161 ) was developed to make it still easier to connect not only with the geodetic triangulation framework but also with spirit-levels of precision and the gravity and magnetic framework, both of which had to be extended and improved to meet post-war conditions. In connection with gravity particularly, quicker methods had to be developed both in the actual gravity measurement and in its height control. Frost ( torsion ) gravimeters were expected to provide the answer to the one, barometric and clinometric heights controlled by spirit-levelling to the other ; with motor transport for rapid movement. A fleet of some 60 “four-by-four” weapon carriers and jeeps was in process of formation for this and other purposes in 1946.

187. As war work developed on the scientific side in 1942 and 1943—the provision of trig. dossiers, preparation of much enlarged tide-tables, star charts and almanacs, adjustments of triangulations, grids, etc., and fitting them to geoids of various elements—it was clear that the Geodetic Branch, overwhelmed with all sorts of non-geodetic work, could not deal with everything and the War Survey Research Institute was formed, to be continued after the war as the Survey Research Institute.

It was also clear that the pre-war system of utilizing all round survey officers as part-time scientists would not serve our post-war aims and that it would be essential to have some whole-time scientists of Class I and Class II calibre in addition to our single pre-war Class I specially recruited scientist, the Mathematical Adviser. The formation in India of a National Physical Laboratory and our agreement to function with this body in respect of time, length and other standardizations, led to the recruitment of certain scientific officers who would deal with such subjects and ( being on the same rates of pay ) could be interchangeable with the N.P.L. officers.

We thus ended the war with a resuscitation of scientific work, somewhat moribund in 1939, nearly dead in 1942 and in 1946 a strong organization whose sole task was scientific work. This organization included, in embryo, a small Mathematical Instrument Office to take the place of our old M.I.O., permanently lost to us by the temporary reorganization of 1941 ( para 73 ) permanently implemented in 1946.

188. In 1939, the Geodetic Branch was a sort of utility circle that did a little of everything, thanks to the retrenchment of 1931.

During the war, it developed into a tremendously powerful map publication circle and administrative office, divorced from scientific work because of the Research Institute and from topographical work by the transfer of its party to Eastern Circle ; but heavily involved in large scale war surveys ( Cantonments Party ) and with its fine compound cluttered up with stores buildings, printing rooms, studios and what have you—to the great detriment of its scientific observatories.

The post-war re-creation of a Central Circle continued to relieve the G.B. of that type of work ; the establishment of the Director, Map Publication at Hāthibarkala made it possible for that circle to take over the G.B. publication work ( though with some administrative difficulty because of the very complex war muddle of buildings in the compound ) ; and the amalgamation of what was then left of the Geodetic Branch with the war-created Research Institute brought the Branch back where it should be—the successor of the “Great Trigonometrical Survey” a flourishing scientific organization whose task was to serve India in purely scientific matters as applied to surveys.

189. The Eastern Circle, the only truly regional circle of the Department in 1939, became almost entirely a drawing circle in the war, to be the first circle after the war to regionalize again. A Southern Circle was formed again, more or less concurrently. The Frontier Circle of pre-war days was to become the Western Circle of post-war, divorced from all military affairs except training for which its terrain about Abbottābād was some of the best in India both physically and climatically. The Military Circle was to remain, at least for some time, to tidy up demobilization, war accounts, etc., and initiate a post-war civil/military liaison system, the military survey service being retained with a Director of Survey (India) heading a Geographical Section, General Staff, with Assistant Directors in each military Command, a Survey Depot and some military survey units at least in nucleus to which officers of the R.I.E. could be attached or posted for training or tour of duty.

Burma ceased to be a responsibility of the Survey of India except in so far as we could supply volunteers for service in the Survey of Burma and instruments, etc., to get the new department started. And, such Survey data as was available in India, saved from the 1942 wholesale losses to the Japanese.

190. In 1945, there was little geographical ( regional ) organization, even less than pre-war ; by 1946 redistribution was in progress to Western, Central, Southern and Eastern regional Circles together with the amalgamation of Geodetic Branch and Research Institute and co-ordination of all map publication under one head ; with the Military Circle continuing to function as the civil link with the new military survey service and as the Surveyor General's military advisers and staff. This circle was also very busy with demobilization and connected problems.

As the war ended, the strength of the Survey of India, including those on military service, was 2,957 all ranks excluding class IV servants, compared with 1,400 pre-war. The expanded Department as sanctioned in 1946 would comprise seven circles and twenty-four parties as compared with four circles and the equivalent of twelve parties pre-war, and would absorb all those in the Department at the end of the war who wished to continue serving with it, indeed more than that at least temporarily because of the very large size of some parties required for the big irrigation and other reconstruction projects that had to be put through as quickly as possible. The organization implied the utilization of a Deputy Surveyor General and a number of Deputy Directors, a war innovation that was to be retained as a post-war reorganization feature.

191. In 1939, recruitment schemes for the Survey of India, of long standing and relatively small as they were, were reasonably simple ; during the war, pre-war schemes continued except that no military officers were available and a temporary service, the Topographical Assistants, replaced the permanent Upper Subordinate Service of which the pay was quite insufficient to attract men of the requisite calibre. In 1946 completely new schemes were worked out, including a direct recruited civilian Class I Service additional to the military Class I ; the cadre reserved for promotion from Class II and the Upper Subordinate Service was revised, along with the Class II, to give much better opportunity for advancement by promotion from one service to another, the " Topographical Assistant Service " also being retained.

Up to 1946 it was not possible to be entirely sure what the permanent strength of the Department should be and temporary posts, as in the war, were utilized to a considerable extent but not to the extent of frightening away those who desired to make a permanent career of survey work. Because of shortage of trained personnel, still in the army, personnel on extension and re-employment were retained for some time after the cessation of hostilities.

192. Before the war, work was comparatively small in volume, diverse in scope and widely scattered in India and Burma ; paid for work ( " recoveries " to the Departmental budget ) accounted for about 40% of the gross budget of which more than one-third was due to sales and repairs by the M.I.O. for provincial and other non-departmental bodies.

During the currency of the war, scope contracted but total volume vastly increased particularly in respect of training and map publication; geographically, the Survey of India was concentrated in four main centres, Delhi, Calcutta, Dehra Dūn and Murree/Abbottābād, with the exception of the very widely scattered No. 20 (Cantonments) Party and the small South India Detachment. Paid for work, mostly map publication, accounted for over 90% of the budget for 1944-45.

In 1945-46 volume of work remained very heavy but was again diversifying both in scope and geographically, Burma, however, remaining outside our orbit and busy forming its own survey department, staff and instruments mainly being supplied by the Survey of India. Paid for work was responsible for nearly 100% of our gross budget.

193. Details of various subjects, arranged alphabetically, will be found in the following portion of this book with detailed statistics in the tables of which Tables C, H and J respectively indicate the expansion in personnel, map publication plant and map publication and issues.

Some budget figures will complete the picture:—

			1938-39	1944-45
			Rs.	Rs.
Survey of India, complete	..	Gross	39,15,800	70,50,000
		Nett	26,41,000	45,57,000
Math. Instrument Office	..	Gross	3,15,700	..
		Nett	1,40,700	..
Purely scientific works, Geodetic branch : W.S.R.I.	..	Gross	1,29,000	1,84,100
		Nett	94,500	1,82,500
No. 20 (Cantt.) Dett./Party	..	Gross	72,100	3,09,800

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**ANNOTATED INDEX**  
**AND**  
**GLOSSARY**

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## ANNOTATED INDEX AND GLOSSARY

*Cross references between headings are shown in italics.*

### ACCOMMODATION

The Survey of India had its own offices in Calcutta ( Map Publication ), Dehra Dūn ( Geodetic Branch ) and Shillong ( Eastern Circle ) and those in Maymyo occupied by the Burma Survey Party were owned by the Government of Burma. New Survey of India offices were near completion at Risālpur when the war started and were under construction in Murree ; the units of the Frontier Circle at those places meantime were occupying hired buildings, as they had done since the Circle's formation in 1925. The Frontier Circle headquarters and drawing office occupied hired buildings in Simla, allotted from the Government pool there. The South India Party was also in hired buildings in Bangalore.

When parties took the field, a building was usually hired at field headquarters to accommodate office, drawing and computing staff, and stores. The Lahore Detachment was so accommodated in 1939.

2. The Surveyor General's Office, on its move from Calcutta to Delhi in 1940, was accommodated in the Temporary Secretariat buildings in Old Delhi that had been put up as a temporary measure while New Delhi was under construction. As the war progressed and accommodation in Delhi and New Delhi tightened up, the office moved to hutments behind the Temporary Secretariat, cold in winter and hot in summer but roomy ; movement to New Delhi was considered once or twice but it was decided to remain where we were so as to have elbow room and reasonable security of tenure. In that we were perhaps wise, for nearly everyone in New Delhi moved several times during the course of the war ; we remained where we were and were able in addition to obtain sufficient space alongside the Surveyor General's Office to accommodate the military wing office of the Director, Frontier Circle when he moved from Simla and later the Military Circle. See *Frontier Circle, Military Circle*. There was also room nearby to build the *Central Map Depot*.

3. Early in the war the Eastern Circle was moved *en bloc* from Shillong to Dehra Dūn where it was accommodated in hired buildings and a building loaned by the ex-Maharaja of Nābha, its own offices in Shillong being handed over to the army for a hospital, later an Area Headquarters ; when the South India Party moved to Dehra Dūn soon afterwards, part of its office in Bangalore was lent to the army.

The move of the Eastern Circle and South India Party began the accommodation troubles in Dehra Dūn soon augmented by the creation of the *Stores Organization*, which had to be accommodated for a long time in hired residential buildings but eventually had 13 large buildings specially constructed for it in the Geodetic Branch compound where, also, many smaller buildings and additions to existing buildings were constructed to cope with the great expansion that occurred in map publication and other work.

When it was decided to build a new "map factory" at Dehra Dūn a very large building project resulted, see *Hāthibarkala*.

The Survey Depot was also accommodated in Dehra Dūn in Government owned buildings from 1943 onwards and a little later barracks for the British technicians employed in the Geodetic Branch and Hāthibarkala were built, see *Cadres*.

4. Except to provide quarters for the recess strength of Class IV servants (khalāsis) it had not been the policy to provide any Government-owned residential accommodation for Survey of India personnel or, except in Simla and Delhi, to allot through Government agency any hired buildings; each person normally made his own arrangements.

This was quite satisfactory in peace—provision of accommodation is difficult because of the seasonal nature of survey work—but during the war presented great difficulty; transfers were very numerous and as more and more troops came to India and more and more shadow factories, etc., sprang up in the interior of India, it became a very serious problem so far as the Department was concerned. All personnel had the greatest difficulty in finding a place to live.

The building of the Hāthibarkala project, which included residential accommodation, however did much to ease this situation in Dehra Dūn; it had before this become extremely difficult. It was by no means easy, either, to procure tents; the B.O.R.'s did however live for a long time in tents provided by the army, in the Geodetic Branch compound.

5. Up to 1946, there was little easement in the residential situation in most places; when the Eastern Circle moved to Shillong at the end of 1946 it had to move in nucleus and utilize some of its office accommodation as dormitories.

## ADJUSTMENT

The adjustment of triangulation is referred to directly or indirectly in numerous places in this book. See *'Irāq, Computations, War Survey Research Institute, Triangulation, etc.*

The adjustment of edges of adjoining map sheets or plane-table sections is inherent in all forms of survey work and forms a major item of survey inspection and map examination duties,

## ADMINISTRATION

Administrative work naturally increased greatly during the war with expansions, building projects, the formation of a large *Stores Organization*, creation of special training units dealing with both soldiers and civilians and, not least, the shortage of certain grains and the rise in cost of living. Food rationing and cost caused many representations to be made for higher pay and allowances, leading to adjustments in the pay and promotion systems which involved a very great deal of study and examination and correspondence with the Government of India. The average number of letters handled in this office before the war was about 9,000; in 1945 it was about 15,000 which gives some indication of the increase in work, though not a full indication because so much of it was the study of schemes for improvement in organization, pay and so on.

2. To cope with the increase, the Surveyor General's Office had to be expanded and reorganized several times.

A post of Additional Assistant Surveyor General (A.A.S.G.) was created in 1940 and filled by Rai Sahib (later Rai Bahadur, M.B.E.) D. C. Verma who was promoted from Registrar to this Class I post; in 1942 the designation was changed to A.S.G. (Organization and Establishment), the designation of the original post of A.S.G. being altered to A.S.G. (Administration). The latter post had been filled by Mr. O. N. Pushong, re-employed after retirement from the post of O.C., M.R.I.O., from 1941 when Major Bomford, the last military incumbent, was mobilized for service in 'Irāq. Verma and Pushong remained in these posts for the remainder of the war and the early reconstruction period; this continuity of tenure did much to relieve me of detailed work.

The office was completely reorganized by Rai Bahadur Verma in 1944 to decentralize work still more; by this time, a number of the senior S.G.O. clerks had gained considerable experience of war administration and were fully competent to make decisions on matters of detail and take responsibility for them. We were able suitably to reward these new heads of sections with enhanced pay and status, the Government of India being fully cognizant of the very great increase in work and responsibility brought on the S.G.O. by the war.

3. Circles and units were correspondingly involved in increased administration, in particular the Geodetic Branch at Dehra Dūn, see *Geodetic Branch*, and the Map Publication Circle because of its splitting into two and the organization of the large Hāthibarkala project, see *Map Publication Circle* and *Hāthibarkala*.

We would have liked to decentralize Dehra Dūn from Delhi, while at the same time centralizing administration within Dehra Dūn itself where there were no less than four separate Circles; many schemes for doing so were mooted and discussed but none was feasible because of lack of sufficient experienced personnel who could be spared and financial-cum-audit difficulties; new financial

and audit regulations would have had to be drawn up, for existing regulations were based entirely on the circle administration system ; no "super-circle" was allowed for.

4. Many special problems arose out of the semi-military nature of the Department which are mentioned under *Frontier Circle, Training Units, Military Circle, Discipline*, etc.

In peace, the Survey of India contained a high proportion of regular military officers in its Class I Service and a comparatively small number of soldier surveyors many of whom had however taken their discharge from the army ; otherwise, it contained no military personnel. During the war, it had many military officers and other ranks attached to it for duty or training while on the other hand many of its regular military officers were transferred to military duty. Some of these problems are discussed in the headings referred to above and in *Cadres, Military Organization*, etc.

### ADMINISTRATIVE OFFICER

An administrative officer was eventually appointed to care for the troubles of soldier surveyors and other soldiers under training in the Surveyors' Training Party of the Survey of India. He was a military officer with the requisite power to indent for rations and clothing, etc., and to dispense discipline with a detachment officer's powers under military law. See *Training Parties*.

"Administrative officers" were appointed from time to time in various circles and parties to assist the officers-in-charge and directors through particularly trying periods. No special administrative establishment was created as a permanent measure, however, except in the Surveyor General's Office and at Hâthibarkala. See *Administration and Directors*.

### AERONAUTICAL CHARTS

The 1/1,000,000 ( 1/M ) International Series produced by the Survey of India had been published in a special edition with certain aviation information surprinted such as magnetic isogonals, position of airfields, etc., and this was continued through the war. This map was made on a polyconic ( Lallemande ) projection, on which magnetic bearings could be represented by sensibly straight lines, radar bearings however being curved lines. The map was thus entirely suited to conventional ( compass ) navigation but not to radar navigation.

The United States Air Force had prepared, and used, a series of charts based on the Lambert conical orthomorphic<sup>(1)</sup> projection, on which radar bearings are sensibly straight lines but magnetic bearings are curved lines. The Survey of India was not required to produce any of these charts during the war but was asked to be prepared to do so after the war, if it was decided to adopt the American charts as standard aeronautical charts, at the International Air Convention in Chicago in 1944.

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(1) In America called "conformal conic".

2. It happened also that the somewhat random arrangement of the American charts placed the flying lane from Calcutta to Karāchi just on the border of two charts and hence ( on the Lambert projection ) with maximum scale error. Their use also meant yet another map series for the Department to undertake, our bugbear before the war, see *Map Policy*.

We therefore protested in favour of adhering to the International system but agreed to abide by the majority vote and, if necessary, to produce charts on the American system.

Up to 1946, no decision had been communicated to us.

3. See also *Civil Aviation* and Sample Chart in pocket at end of book.

## AFGHĀNISTĀN

Before the war the Afghān Government had requested the Government of India to supply about one hundred copies of each of the  $\frac{1}{4}$ -inch Survey of India map sheets that covered their country, some 91 sheets in all. As all but Afghān territory was to be masked out, this job ( in full colours ) took some time and was further delayed by the outbreak of war necessitating our publication strength, then relatively small, being applied to war maps. It was completed eventually however and reprints were later made and supplied.

2. A survey to locate coal bearing areas in Afghānistān, north of Kābul, was also in progress when the war started and a small detachment under Mr. Chiragh Shah ( later Khan Sahib ) was employed on the work under the orders of the Geological Survey of India. This work was carried to completion in the early years of the war and resulting maps published for the Afghān Government with names in English on one series and in Persian script on another.

There was a general map on  $\frac{1}{2}$ -inch scale and several maps of adits on larger scales.

During the course of the work Mr. Chiragh Shah had opportunity to establish a valuable triangulation link between the Haibak 1884-86 and Kurram 1878-80 series by occupying a station on the crest of the high Koh-i-Kotal ridge ( 15,212 feet ) that lies between them. He also made friendly and valuable contacts with Afghān Government officials.

3. Between 1944 and 1946 fourteen officers of the Afghān army were trained in the Survey of India in various survey and map publication duties. Of these, six were selected for a two or more years course in the later stages specialising according to their bents, the remainder being given short ( six month ) courses in general surveying, mainly use of theodolite and plane-table.

The specialists, with whom it was intended to form the nucleus of a Survey Department of Afghānistān, completed about a year with the training units in north-west India, after which they joined.

other circles for advanced training. Those required to study geodetic subjects had much difficulty with English and mathematics; a university course seemed essential before they could progress far in these scientific fields.

4. The Afghān Government offered to the Survey of India on loan a Wild A 5 autograph that they had purchased just before the war. Inspection at Kābul by Lt.-Colonel Crone showed the instrument to be in good order except for a missing "Z" carriage and one or two minor parts. The machine was transported to Dehra Dūn where it was erected by a co-operator Italian prisoner of war ( Lt.-Colonel Gallina ) under Lt.-Colonel Crone's direction.

Unfortunately, acquisition of a new "Z" carriage took a very long time, though we were in direct communication with Messrs. Wild in Switzerland who kindly removed a carriage from one of their machines for us ; the result was that we were unable to use the machine in our preliminary reconstruction surveys or train the young Afghān officers in its use as had been intended.

The Survey of India did not itself possess such an instrument.

5. We were requested also by the Afghān Government to assist them in certain irrigation projects that they had in view late in the war and early in the reconstruction period, but we were ourselves so very short of personnel for the same purpose in India, that we were unable to comply in full ; we did however offer a small detachment, all that we could spare.

## AGRICULTURE DEPARTMENT

Towards the end of the war, the Department of Education, Health and Lands was broken up into three, the Survey of India coming under the control of the Department of Agriculture.

See *Education, Health and Lands* for further details.

## AID SURVEY FRAMEWORK

The distance apart of high precision ( geodetic ) triangulation series and also of precise levelling lines led to considerable delay in starting off very urgent irrigation and similar surveys during and immediately after the war.

Provided it could be achieved reasonably cheaply, it was decided to try to cover all India with a fairly close network ( about 10 to 20 miles squares ) of "All India Development Survey Framework" monuments, whose position and height would be fixed with high precision and marked upon them, together with other data such as the magnetic declination at that point and the value of gravity ; it would thus be possible to start surveys of any sort for engineering or any other purpose from a fixed point never more than 10 or at most 20 miles away, and similarly close such surveys.

2. This idea, emanating from Dr. de Graaff Hunter, was being developed by the War Research Institute under his direction at the

close of the war. A suitable monument had been designed and the Public Works and other departments approached for assistance in the maintenance of the marks, which they readily agreed to give; the Government of India had also sanctioned funds for the necessary experimental work.

Precise traverse methods ( see *Traverse* ) were to be followed in establishing these marks and experiments were carried out during 1945-46 in respect of cost and accuracy. It was intended to work at the outset in the areas in which there were the most important irrigation projects.

Up to the end of 1946 methods and apparatus had not reached finality, though some trial lines had been run on the ground. See *War Research Institute*.

3. A considerable amount of levelling of high precision might be involved in the establishment of this framework, both to establish the heights of monuments themselves and to control gravity measurements, see *Gravity* in the latter case.

## AIR CHARTS

See *Aeronautical Charts*.

## AIRCRAFT

The Survey of India possessed no aircraft, all photographs having been taken in peace by the Royal Air Force or ( mainly for a few special surveys ) by Messrs. Indian Air Survey and Transport Ltd. of Dum Dum, Bengal.

During the war however the necessity for aircraft under our own control was very badly felt and a charter was negotiated with the above-named firm to place certain aircraft at our disposal. Details under *Indian Air Survey and Transport*.

2. The need for large, high ceiling, aircraft was very badly felt in the latter part of the war for photographing a portion of the high ground ( 15,000 to 20,000 feet or more ) in north-east Assam. See *Assam*.

## AIR PHOTOGRAPHS

Before the war the majority of air photographs used by the Survey of India had been taken by the Royal Air Force, mainly on the N.W. Frontier and over Tribal Territory. Messrs. Indian Air Survey and Transport, Ltd., of Dum Dum, Bengal had however taken a considerable number, particularly in connection with special surveys on larger scales.

R.A.F. photos, except in the very early days, were taken either with the F.8 ( 7" × 7" ) or the F.24 ( 5" × 5" ) cameras.

2. During the war a charter was arranged with I.A.S.T. and large quantities of photographs were taken by them not only for survey purposes but also for camouflage checks and other special

purposes. The cameras used were the Williamson Eagle F.8 with lenses of focal lengths  $4\frac{1}{2}$ ",  $8\frac{1}{4}$ ", 10", 12" and 21" and also a F.24 camera with lenses of focal length  $3\frac{1}{4}$ " and 14".

The size of prints supplied was 8"×7" when using the F.8 camera except when the 21" lens was used when the prints were 7"×7". The F.24 camera prints were 5"×5".

The Indian Air Survey and Transport Co. at first used only De Havilland Leopard Moth machines which could carry the pilot and 2 passengers. After the beginning of 1946 they also used De Havilland Dominie aircraft twin engined bi-planes, capable of carrying the pilot and 6 passengers and having a much higher ceiling than the Leopard Moths.

In all the Company took a total of 54,962 photographs under the charter ( up to July 1946 ).

Further details will be found under *Air Survey*, *Air Survey Party*, *Indian Air Survey and Transport* and *Libraries*.

## AIR RAID PRECAUTIONS

A.R.P. was necessary in Burma ( Maymyo ) where adequate slit trenches and blast walls, etc., prevented casualties and serious damage when Maymyo was bombed early in 1942, and in Calcutta ; blast walls were built round the tide predicting machine at Dehra Dūn, but otherwise few precautions were taken in Survey of India offices except Calcutta, all being far from the danger zone.

Shillong had been vacated before the Japanese threat occurred, see *Eastern Circle*.

2. In Calcutta, full precautions had to be taken. Blast walls were built round vital parts of the offices, auxiliary underground water tanks built, slit trenches prepared and fire precautions, including fire-watching, taken. The office roofs however were old and it was a moot point whether the sand placed there for fire protection was not more of a danger than a Japanese bomb ; in any case it was removed and no bomb struck in or near the offices.

3. Fire-watching absorbed too much time and energy. Against considerable die-hard resistance, new offices were built at Hāthibarkala, Dehra Dūn after which the Surveyor General at least breathed more freely. Too many map publication eggs were in the Calcutta basket, for ease of mind.

No damage was done when Calcutta was bombed and it was not often bombed ; but at that juncture it would not have been wise to rely on that. See *Hāthibarkala*.

4. Some tiresome but nevertheless amusing administrative problems arose out of the supply of warm clothing and warm drinks to night fire-watchers. It appeared that concessions to those required to watch and protect Government property had not been considered.

Local initiative was however successful in producing both clothing and warm drinks for fire-watchers.



## AIR SURVEY

A considerable area on the North-West Frontier of India had been surveyed by air methods, mainly the "Arundel" or radial line method, and work on outstanding areas that had been photographed by the R.A.F. was in progress in the Air Survey Party (Risālpur/Murree) when war broke out. The plumb point method was also in use in some areas where obliques were necessary and ground control was very sparse necessitating the use of the stereocomparator, one of the few precision air survey instruments possessed by the Department. It will be understood that ground control could not easily be carried out in the Tribal Areas.

Work in other parts of India had been done by various methods and combinations of air and ground methods, for instance the Irrawaddy Delta survey, the Nāgpur City survey, the Tripura survey. These are described in the relevant annual General Reports of the Survey of India.

A number of officers and subordinates of the Department had been trained in the radial line and other relatively simple methods; few had mastered the plumb point method, the use of the stereocomparator or such instruments as the Wild autograph which indeed only about two officers had ever seen.

The "Canadian" ground survey method was used from time to time in augmenting air surveys or in particularly suitable terrain. The Department possessed a Canadian camera and a Wild phototheodolite.

The stereoscopes used were mainly the Mathematical Instrument Office pattern of table stereoscope, widely used also by army engineers and intelligence officers, and the M.I.O. head stereoscope. We had also a few Barr and Stroud, Type ZD.10.

It was our policy to concentrate on simple methods and instruments, easily learnable by all who possessed good stereoscopic vision.

2. The policy referred to above was dictated by the facts that the majority of our surveyors were not up to the standard of education required to master complicated methods and that the majority of our surveys were to be carried out on scales of about one inch to a mile, seldom on a scale larger than  $1/25,000$  (about  $2\frac{1}{2}$  inches to a mile). In special cases of scales larger than  $1/25,000$  special methods were used and personnel specially trained in them.

We could not know that, whatever might be the very exacting needs of war, it would be advantageous to be thoroughly *au fait* with large scale methods immediately after the war and to possess modern high precision and high priced instruments. Considerable improvization was therefore necessary in the latest stages of the war and immediately after it, to meet the many and urgent demands for large scale reservoir surveys and the like. See *Projects*.

3. Mass production methods had not been carried out before the war. The accent had been on simple methods and on training

as many men as possible in all branches of these methods, so that each individual might be to a great extent self-sufficient in air survey when occasion arose to use it. Lack of Department owned aircraft and the expense of air photos from other sources made this policy essential, coupled with the fact that the Department possessed many very fine plane-tables and that ground survey on any but exceptional scales was as cheap as, or cheaper than, air survey.

During the war, mass production was developed to some extent in the Survey of India, to a much greater extent, however ( using "unskilled labour" to the utmost ) in its military counterpart. A major innovation was the acquisition early in 1943, from the Fairchild Corporation of America, of two "Slotted Templet" sets, on lease. These were lent soon after to the military survey service and eventually returned to us when the British slotted template sets became available. The function of this ingenious device is to duplicate in physical form the line work of the "minor control" of the air survey. By distorting the physical framework one is able to carry out very speedily and accurately the "adjustment" necessary to fit together several minor control plots, a troublesome task by ordinary methods.

4. During most of the war, the air survey activities of the Department were directed mainly towards training military personnel, both military survey service and others. Towards the end and after it, considerable air survey was done to meet reconstruction requirements in respect of irrigation and flood control projects. Some time was found, off and on, to further N.W.F. surveys in progress when the war started. Surveys ( small scale ) were required in Assam for political reasons. Some correction survey was done in Burma in the early stages, before the evacuation. Direct survey help was given to the military survey service in certain items such as mapping artillery ranges ; our direct help to the army, however, consisted mainly in the training and supply of personnel.

These various activities are described in the three headings that follow immediately and under *Assam, Burma and Burma Survey Party, Indian Air Survey and Transport and Projects*.

## AIR SURVEY DIRECTORATE

Under the war establishment current before the war, each field survey company to be raised in India contained an air survey section which was more or less self-sufficient with some reproduction plant and personnel ; the sections were so organized that it would be possible to "brigade" them if necessary. In 1942, the military air survey situation demanded that larger complete units should be organized and a war establishment for an air survey company ( as opposed to a *field* survey company ) was sanctioned by G.H.Q. ( India ). Two such companies ( Nos. 5 and 7 Ind. Air Survey Companies ) were raised during 1942-43, absorbing the majority of the trained air survey personnel of the Survey of India. They constituted the Air Survey Directorate under the control of Colonel

D. R. Crone, O.B.E. and we were able to obtain for No. 5 Indian Air Survey Coy. the old offices of the Northern Circle of the Survey of India, in the Castle Hill Estate at Mussoorie, that were relinquished by the Survey of India some years before but had remained Government property. No. 7 Indian Air Survey Coy. was accommodated at Risālpur in the new offices there.

These units remained in Mussoorie and Risālpur respectively till 1944, carrying out military mapping work under the orders of the Director of Survey ( India ) at G.H.Q. They were then transferred to the technical control of the Director of Survey, 11th Army Group and moved to Harihar in the Southern Command. The Air Survey Directorate, as such, was dissolved. Colonel Crone reverted to Survey of India employ, continuing, however, to be Air Survey Officer of the Survey of India as he had been while performing the duties of Deputy Director of Survey, Air Survey Directorate. See *Air Survey Officer, Projects Officer*.

## AIR SURVEY OFFICER

Air survey work in the Survey of India had been carried out almost entirely by No. 18 ( Air Survey ) Party in the years preceding the war. The majority of its air survey work continued to be carried out by this unit during the early stages of the war; during the later stages, however, much work in connection with projects was carried out in other units and as early as 1943 the necessity for a staff officer to the Surveyor General to co-ordinate all the air work of the Department, as well as to co-ordinate military and civil work, was badly felt. For this reason Colonel Crone, though in-charge of the Air Survey Directorate under the Director of Survey ( India ) was, with the latter's consent, required also to perform the staff duties of Air Survey Officer to the Surveyor General.

2. Concurrently with the dissolution of the military *Air Survey Directorate* in 1944, a post of Projects Officer was created in the Survey of India to co-ordinate and organize demands for surveys in connection with "grow more food" and preliminary works in connection with post-war reconstruction. This post was filled by Colonel Crone on relinquishing his Air Survey Directorate duties and the post of Air Survey Officer, Survey of India, amalgamated with it.

Until 1946 the Projects/Air Survey Officer functioned in Dehra Dūn; thereafter his headquarters was in the Surveyor General's Office at Delhi. See *Projects Officer*.

## AIR SURVEY PARTY

No. 18 ( Air Survey ) Party of the Survey of India was formed in 1925 when the Frontier Circle was created and lived its early life in hired offices in Peshāwar Cantonment where it was in close liaison with the R.A.F. Owing to the difficulty of doing good work in the

extreme heat of the Peshāwar hot weather, it moved each spring to summer quarters in Murree, also in hired buildings, where it was in close touch with Northern Command, which used to move each summer from Rāwalpindi to Murree.

When the main air station of the R.A.F. was transferred to Risālpur, No. 18 Party also moved there, again in hired offices, continuing to "recess" in Murree.

Just before the war, new offices were constructed to our own design in Risālpur to house this unit as well as a topographical party and somewhat similar offices were under construction in Murree; in both places provision had been made for the housing of a small reproduction section and we had acquired a tractor-trailer by means of which our single rotary offset machine in that area could be moved back and forth between Plains and Hills or, if necessary, to any road base in case of Frontier war.

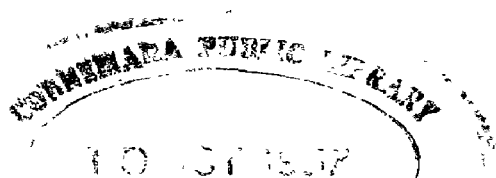
18 Party was thus more or less self-supporting as regards map publication. Until the war, however, "standard" maps of the Survey of India were not produced there, activities being confined to special maps for the Northern Command and the Air Force besides such reproduction work as was necessary for the various steps in the making of a map by air survey methods. Several military exercises had been carried out, involving the rapid preparation and publication of maps from air photographs. Some of these were in co-operation with considerable bodies of troops.

2. It was fortunate that the new offices were well in hand when the war started. They were spacious and enabled us to accumulate and properly store all mobilization equipment, previously somewhat scattered; this was in charge of No. 18 Party, the "permanent" resident of this area—the topographical parties moved about.

The offices in Risālpur also provided mobilization headquarters for the first units and later housed a military reproduction group. The reproduction section of No. 18 Party was expanded to the capacity of the Murree offices and for the major part of the war undertook all map publication required in Northern Command and N.W. Army (including the publication of standard Survey of India sheets for this whole area) besides providing a small extra amount of publication power for the general "pool" of the Department. Considerable stocks of maps of the N.W. Army area were also held in these offices.

3. Thanks to the space in the new offices, we were able to undertake the training in air survey of a considerable number of officers and other ranks, both civil and military, at one time. This was mainly carried out in Murree where it was possible (though difficult) to find residential accommodation for trainees, No. 18 Party remaining in Murree throughout the winter for most of the war.

It has been mentioned in an earlier heading (*Air Survey*) that the policy of the Department before the war was to train its air surveyors in all branches of one relatively simple method (the



radial line method) of air survey, only a few who showed very special aptitude being trained in more complicated methods. It was therefore necessary in the early stages of our training commitments to train up instructors who would be able to meet the needs of the moment which were very varied—trainees in 18 Party consisted of our own officers and surveyors, military officers of the R.E. and R.A., B.O.R.'s of the R.E., R.A., and Intelligence Service (Air Intelligence Liaison) and, by no means least, Soldier Surveyors who though replacing civil recruitment in the Department for the period of the war, were not actually members of the Survey of India. See *Soldier Surveyors*. Refresher courses had also to be undertaken and finally, as the war neared its end, training in special methods adapted to the needs of reconstruction surveys to be undertaken against time. See *Projects*.

The officer-in-charge of the Party was thus confronted with a number of different training syllabuses that he must draw up and keep up to date as military requirements changed and at the same time cope with the many and varied problems relating to rations, discipline and the like; he not infrequently also had to “double” as Director or Deputy Director, Frontier Circle owing to shortage of officers.

There was consequently little time for research, one of 18 Party's normal functions, and as training demands increased, so routine survey work had to be shelved.

The general training pattern is discussed under the heading *Training*. Full information about Survey of India air survey methods is contained in Chapter XII of the Handbook of Topographical Surveying and an abridged version is in Part XII of the Survey Service Pocket Book.

4. No. 18 Party had a heavy programme of N.W. Frontier mapping when the war broke out. As other commitments supervened, this was gradually dropped and eventually shelved altogether. Training commitments became so heavy that very little other work could be undertaken, except such as could be carried out by the trainees themselves.

In the early stages of the war, the party lost much of its trained personnel to mobilized units and as instructors in other branches of surveying. It took some time to build it up again into the strong training and air survey organization that it eventually became in the later stages of the war.

It was not till 1946, however, that the party had changed over to civil map production; even then it was not out of difficulty because the much wider use of air survey methods in reconstruction surveys necessitated decentralization to other branches of the Department and No. 18 Party yet again had to build itself up to an organization whose primary functions were research and specialist training, while at the same time undertaking current surveys in its own area, roughly that of N.W. India and Kashmir.

5. For the latter part of the war, a small military section was attached to the party so that the Director of Survey ( India ) would have at call some air survey power of his own, supervised, however, by the officer-in-charge of No. 18 Party and his assistants.

This section did a considerable amount of work in connection with artillery training maps.

6. During the war this party trained an enormous number of officers and other ranks in air survey work. Some of these did a full course of air survey training which fitted them for regular employment in the Survey of India on productive air survey work. Others did refresher courses or short courses which were designed to fit them for the more rough and ready methods employed in military survey units. As an example of the numbers involved, in the year ending 31st July 1945, two Upper Subordinate officers, two Topographical Assistants and 53 Surveyors did full Survey of India courses in air survey. In addition 13 Emergency Commissioned officers of the Royal Artillery and 68 British Other Ranks were put through courses of varying lengths.

## ALFSEA

Allied Land Forces, *South-East Asia Command*.

## ARMY SECTION, No. 6 DRAWING OFFICE

No. 6 Drawing Office of the Survey of India was the regular Frontier Circle Drawing Office ( one such office being allotted to each circle of the Department ) and had been located in Simla since the formation of the Frontier Circle in 1925. See *Frontier Circle, Drawing Offices*.

Included as part of this office, though housed in Army Headquarters and under the orders of the General Staff ( M.I. 4 ) for its work, was the "Army Section". This section was responsible for the production of certain special maps for the army ; it was commanded by a major on the I.U.L. promoted from among the British draughtsmen who formed the drawing staff of the section and contained a small reproduction section manned by Survey of India personnel who, however, were on different rates of pay from other reproduction personnel of the Department.

The section was administered by the officer-in-charge of No. 6 Drawing Office under the control of the Director, Frontier Circle who was also responsible for providing the necessary technical advice.

Overflows of work from the Army Section were normally carried out by No. 6 D.O., and vice versa if the Army Section happened to be short of work.

2. When the *Geographical Section, General Staff* ( G.S.G.S. ) was formed in 1942, the Army Section was transferred to the control of the Director of Survey ( India ) and thereafter worked under his

orders, Survey of India personnel in the section being transferred to the army ( civil ) organization. The men concerned were asked, after terms of service were decided, whether they preferred to remain in this section under army control or to be absorbed in the regular Survey of India reproduction staff, under our terms.

The name of the section was also changed to "General Staff Drawing Office, Simla".

3. The section was equipped with one flat-bed printing press and several proving presses. A considerable amount of its work was done by lithography ( on stone ), a process no longer used by the Survey of India itself.

The output of the Army Section is referred to in Table J.

## ASSAM

In peace, the Eastern Circle of the Survey of India with offices at Shillong was responsible for work in Assam. Early in the war this circle was moved *en bloc* to Dehra Dūn, leaving no personnel in Assam. See *Eastern Circle*. Routine surveys had been in progress but, in common with the rest of India, were dropped in favour of war work. There was no particular call for survey personnel in Assam until the Japs entered the war and the threat to India developed.

2. In 1942, when the Ledo and other bases in Assam were being developed, and the road to China ( Stilwell Road ) was commenced, there was much survey work to be done. In anticipation of requests for work in this area, No. 12 ( Topographical ) Party of the Eastern Circle was made ready for the field early in 1942 and its despatch to the field in north-east Assam actually coincided with a most urgent request for help from General Wood, then in charge of organizing for the great influx of troops that was to occur later ; we were able to telegraph in reply that a party was already on its way.

This party carried out some topographical survey on smaller scales and a great deal of larger scale work to assist in the siting of base organizations, airfields, railways and the like. At the outset, it worked directly under the orders of the Director, Eastern Circle at Dehra Dūn. Later, it worked under the orders of the Dy. Director of Survey, Eastern ( later 14th ) Army, though still remaining a civil unit, administered by its Director in Dehra Dūn.

3. No. 12 Party alone could not cope with the great amount of work to be done, nor did it have so much experience of large scale work, traversing, etc., as No. 20 ( Cantonments ) Party ; detachments of the latter unit were therefore sent to assist, also working under the orders of the Dy. Director of Survey, 14th Army, while continuing to be administered from Dehra Dūn, in this case by the Director, Geodetic Branch under whose orders the unit normally functioned.

No. 12 Party, as such, was withdrawn from this area in 1943 as the military survey service grew in strength and was able to take

over the work, but detachments formed from personnel of both 12 and 20 Parties continued to work in the area throughout the war until the Japanese threat had evaporated.

4. Being civil units and administered from so far away as Dehra Dūn as they had to be, yet having their work controlled on the ground by 14th Army, there were difficulties with food, clothing and discipline the more so because regulations in these respects for servants of the Central Government differed materially from those in force for Assam Government civil servants, civilian personnel in army employ, and from army regulations. Nevertheless, these units did admirable work under great difficulties.

5. In 1944 the Government of India ( Political and External Affairs Departments ) asked urgently for topographical surveys of certain large areas in the Bālipāra Frontier Tract and Lohit Valley in the extreme north-east corner of Assam. These could be made only by air surveys ; the terrain was very high and mountainous, reaching to over 20,000 feet in parts and weather conditions were very uncertain. The area concerned is very close to "The Hump" over which supplies were flown to China throughout the latter part of the war.

Our small chartered aircraft ( Moths ) stood by on airfields in northern Assam for many days even weeks and did succeed in brief photographic sorties over the lower parts of the area, resulting in two seasons in about 4,000 square miles of photography. Efforts to obtain the services of a big high-ceiling R.A.F. aircraft were unsuccessful as these could not be spared from other tasks.

## ASTRO-FIXES

Considerable research was carried out by Dr. Hunter in the War Research Institute on this subject, of vital importance to any surveyor accompanying an air-borne force. Fixing position by the sun or even stars is hardly accurate enough for regular survey technique but when a force is dropped from the sky into strange country, it takes on supreme importance. The problem was to attain speed and simplicity while at the same time producing sufficient accuracy, say position within half a mile or less, to satisfy a force commander and to start a survey programme that could later be adjusted to precise terms. See *War Research Pamphlets*.

Astro-fix methods and routine astronomical work ( latitude, longitude, azimuth, time ) were taught in No. 4 ( Training ) Party.

## BĀLIPĀRA FRONTIER TRACT

See *Assam and Projects*.

## BALUCHISTĀN

This portion of north-west India was one of the first to be re-surveyed under the programme framed by the 1905 Survey Committee, see *Map Policy*. Its maps were therefore somewhat out-of-



date in 1939, except that "*E*" Company of the *Frontier Circle* had had its headquarters there from 1926 to 1936 ( after the devastating earthquake of 1935 ) and had done a considerable amount of new and correction survey, the former mostly to the south of Quetta in Kalāt State. Baluchistān was also a military survey training area.

2. No war activity occurred in Baluchistān during the 1939–1945 war. In its early stages, however, some preparations were made which included a military survey on 1/25,000 scale of a portion of the Khwāja Amrān range, south of the Khojak Pass, by No. 1 Indian Field Survey Company immediately after its formation in 1940 ; this met demands from Western District and also provided excellent unit training for our first formed Field Survey Company.

Later on, in 1942–43, there was considerable military interest in the extreme western portion of Baluchistān and the extreme south-east portion of Irān and a special party, the Perso-Baluch Party, was formed to work in co-operation with No. 3 Indian Field Survey Company in rapidly bringing up to date the maps of that area particularly with reference to roads and routes passable by armed forces. Concurrently, a considerable amount of triangulation was carried out to control an air survey for which the photographs were taken by Messrs. Indian Air Survey and Transport Ltd. See *Indian Air Survey and Transport*.

3. During the course of this work, the Officer Commanding No. 3 Company, Major C. A. Biddle, R.E., tried to establish a triangulation connection between India ( Kalāt primary series ) and series established in western Irān based on 'Irāq that had been triangulated under the orders of Paiforce, mostly by Survey of India personnel. See '*Irāq* and *Paiforce*.

Major Biddle was defeated by bad visibility in the region of the Lūt Desert, about which we had at that time little information.

4. In 1944, however, a party of Survey of India personnel returning to India from Paiforce, headed by Captain P. A. Thomas, I.E. and Subedar M. Z. A. Quraishi were successful in establishing the link, following the convoy route from Nain in Irān, via Kermān and across the Lūt Desert, to Zāhidān. This work is described in detail in War Research Pamphlet No. 9. See also *Spheroids*.

## BASE ORGANIZATION

For many years the Survey of India had been responsible for surveys and maps required by the armed forces in India and was committed to supplying, fully equipped as regards technical equipment, certain units. It was therefore natural that it should remain the base organization or installation for the military service when that was formed and for the South-East Asia Command service, when that command took over survey units previously under India's control.

In fact, it was for this very purpose that the Survey of India was officered in its Class I Service mainly by military officers.

Throughout the war, the Survey of India was the base and supporting organization for the military survey forces based on India and for some time it stood by to support Mideast when things were critical there.

2. Until the Geographical Section, General Staff, was formed in 1942, the Survey of India dealt direct with the Director of Military Operations and other military staff officers at G.H.Q. India and also with Mideast and Paiforce under whose control its units were and whom it was assisting with maps.

After the formation of the G.S.G.S., the Department dealt with military formations through the Director of Survey ( India ). See *Military Organization*.

3. To function adequately as a base installation or organization, the Survey of India had to expand very greatly in its map publication, stores and training facilities ; it is this expansion that forms the main subject of this book.

Development was naturally gradual, as the war situation developed ; by the end of 1942, requirements had become clear and had stabilized, but by the end of 1943, the melting pot appeared again in the form of many governmental demands for post-war reconstruction and "grow-more-food" works. The Survey of India spent much of the war in transition from one requirement to another. See *Cadres, Stores Organization*.

## BENGAL

Our main connection with Bengal was of course the fact that the headquarter offices of the Department had been established in Calcutta for many years and that the Map Publication offices in part and the Mathematical Instrument Office, as well as the offices of Messrs. Indian Air Survey and Transport Ltd. ( Dum Dum ) remained there throughout the war.

The work of these offices is described under the appropriate headings.

2. As in Assam, the Cantonments Party did a considerable amount of large scale survey, levelling, etc., for airfields and other military enterprises in Bengal for the most part under the orders of the Dy. Director of Survey, 14th Army. Towards the end of the war, several surveys were carried out to further reconstruction projects, dealt with under the heading *Projects*.

3. Much of our map publication personnel and some of our surveyors, besides a considerable number of officers and clerical staff, came from Bengal. Many of these men were unhappy away from their home province notwithstanding that it was vulnerable to enemy bombing and attack but had perforce to be kept in other parts of India in order to further the war effort to the best advantage.

Late in the war a "repatriation" scheme was introduced and followed so far as circumstances permitted, the continuance of a big office in Calcutta allowing exchanges. The normal outlets for exchange, Assam and Burma, were not open to us ; many Bengalis had in peace time liked to work in these areas. A major point in their dislike of northern India was the difficulty in obtaining rice ; they were accustomed to eat rice rather than wheat. Though the majority did admit that wheat was more suitable for the more rigorous north India climate, they nevertheless—not unreasonably—preferred the diet and climate to which they had been accustomed since childhood. It was, however, noticeable that those who had been born and brought up in their early years in northern India, though of Bengali parentage, were quite happy under the conditions of northern India.

### BLACK PRINT ORIGINALS ( B.P.O.'s )

To enable maps originating in India to be identically duplicated elsewhere if necessary, clean black pulls on high quality smooth paper were taken at time of printing, and despatched to various other offices such as Mideast, similar prints being received from them.

When film became more easily obtainable it sometimes replaced B.P.O.'s.

### B.O.R.'s

The B.O.R. cadre of map publication technicians is described under *Cadres*.

B.O.R.'s sent to us for training in air survey are mentioned in *Air Survey Party and Training*.

### B.O.'s

See *Officers*.

### BURMA

Our connection with Burma was mainly in respect of the *Burma Survey Party*, dealt with in the following heading in which also the timely saving of Burma map originals is mentioned. Without these originals we would have been very hard put to it indeed to publish, as we did, the large number of tactical maps required for the planning of the Burma campaign. When Burma was evacuated, the only complete set of maps of that country, so far as I am aware, was in the Surveyor General's reference portfolio ; these being multi-coloured maps, the task of re-publishing them would have been very formidable indeed and would have taken a very long time.

2. In 1943-44 plans were under formation for the setting up of a completely reorganized Burma Survey Department after the

war, which involved the Surveyor General and one or two of his officers in considerable study and correspondence. Late in 1944 plans were formed in respect of the participation of the military "Civil Affairs Service" in the rehabilitation of Burma surveys; these did not directly affect the Survey of India except that we agreed to spare an officer to become the civil Director of Survey, Burma and to spare certain instruments and equipment as a nucleus on which to build Burma's new department and to call for volunteers for it. See also Chapters V, VI, VII, X 65, 67 68, 85, 87, 141.

## BURMA SURVEY PARTY

Up to the retrenchment of 1932 there had been a full topographical circle in Burma and the country was therefore fairly completely mapped on one-inch and/or half-inch scales as also on the smaller scales. Maps were not of an extremely high standard of accuracy in some parts because of the conflicting factors of intensely heavy jungle and limited finances. They were, however, reasonably serviceable.

After 1932 a strong Survey of India party, the Burma Survey Party, remained in Burma with headquarters at Maymyo and continued to function there after the separation of Burma from India in 1937; after separation the programme of the party was controlled by the Government of Burma (in consultation technically with the Surveyor General of India) but was administered by the Surveyor General and all personnel remained Survey of India personnel.

This party continued the general programme policy that had been in force when the Burma Circle was in existence.

It had no publication staff and all maps were published by the Survey of India at Calcutta, originals being sent to Calcutta as required for the purpose and then returned to Burma for storage. Stocks of maps were also stored in Burma.

2. Early in the war, all map stocks were transferred to Army Headquarters, Burma, at Rangoon; they had hitherto been stocked by the Map Curator, under civil auspices. The Burma Survey Party did not hold stocks except for its own immediate uses.

Except that of the Map Curator, there was no map distribution organization in Burma; the result was that few maps reached the troops and in the end, many thousands of maps were destroyed or fell into Japanese hands. In all, the Survey of India supplied by ship, land and air nearly half a million maps of all parts of Burma before the final evacuation.

The distribution situation improved somewhat towards the end, with the arrival of a Map Supply Section from India\* and the formation of one, from local resources, by the Burma Survey Party.

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\* This section, under Lt. Wilson Jardine, I.E. (E.C.), was unfortunately captured by the Japs. They were prisoners throughout a long period of the war.

I have ventured few opinions in this book but I will venture this one ; that without a strong map distribution organization, set up and well drilled beforehand, maps will not reach the troops in battle. See *Map Issues*.

It was exasperating to the Burma Survey Party that maps it knew were in Burma were not reaching the troops in time but there was little, beyond asking for help from India and forming the Map Supply Section that it did, that it could do about it.

3. On the survey side of the picture, the Burma Survey Party had been engaged, like Indian survey counterparts, in routine survey programmes when war broke out. As in India, these were gradually—but more rapidly than in India—scrapped, and attention focussed on the correction by any means at disposal of existing surveys on lines of approach open to the Japs ; and on the training of personnel in military survey requirements, hitherto mainly confined to Indian units on the N.W. Frontier.

In order to assist in these works, the party was reinforced from India by an additional R.E. officer, a civilian officer and several subordinates who were trained in air survey, with appropriate equipment ; and a small reproduction section was set up in Maymyo operating, however, only with hand equipment. This section was able to turn out a sufficient number of corrected maps and appliqué slips to help a little in filling the gap that must occur if material had been sent to India for reproduction there and return to Burma.

4. By the middle of 1941, the Burma Survey Party had done a considerable amount of correction work partly on the ground and partly from existing air photographs lent by Messrs. Indian Air Survey and Transport Ltd. That company also did some new photography in areas indicated by A.H.Q. Burma. Most of this correction work was on the line of approach through the Shan States.

At this time, Major H. W. Wright, R.E., the officer-in-charge of the party, was made an Assistant Director handing over the party to the senior civilian officer, Mr. A. F. Murphy ( Class I ) ; Captain D. E. O. Thackwell, R.E. assisted Major Wright with military training and organization and in air survey work.

During 1940 Major Wright visited Malaya and Netherland East Indies on a liaison tour and reconnoitred the approach to Moulmein.

Special war establishments, suited to Burma conditions, were also put in hand ; these were based on the current Indian establishments ( designed primarily for the N.W. Frontier of India ) but had to have some alterations particularly in respect of transport to accommodate them to Burma conditions and the personnel immediately available in Burma. It was not till December 1941, when the Surveyor General visited Burma, that the establishments were finally put through ; the decision reached was that the unit should be an Indian unit ( though the Burma Survey Party contained a number of Burmans ) and alternative transport scales were prepared

to allow for M.T. or pack transport or a combination of the two. The war establishments catered for a survey headquarters and a field survey company.

5. No. 6 Ind. Svy. HQ. ( Lt.-Col. Wright ) and No. 6 Ind. Fd. Svy. Coy. ( Major Thackwell ) were raised early in 1942, Lt.-Col. Wright continuing to function as Asst. Director civil as well as military ; Mr. Murphy continued as officer-in-charge Burma Survey Party. About the same time, a Map Supply Section was formed locally and another sent from India ( referred to in paragraph 2 above ).

• The military units were formed mainly from Indian personnel already in Burma though some reinforcements were sent from India ; few Burmans volunteered.

Civil and military units continued to be based on the peace time headquarters at Maymyo. The efforts of all, civil and military, were directed towards bringing maps up to date as far as possible in the fighting areas and in getting maps into the hands of the troops.

6. The bombing of Maymyo caused no casualties and little damage in the survey offices, slit trenches and blast walls having been prepared ; it did, however, cause a number of the Burman personnel to abscond to their homes and a few others who had made permanent homes in Burma—a good example of the moral effect of even light bombing.

When it was decided to evacuate Maymyo the option was given to all Burmans and those Indians who had permanently settled in Burma either to accompany the evacuation columns or to go to their homes ; the latter were given an advance of pay. Those who had absconded were suspended from Government service, pending subsequent investigation of their individual cases.

Only two Burmans accompanied the evacuation columns to India.

7. Survey evacuees went overland in three parties, under Lt.-Col. Wright, Major Thackwell and Mr. Murphy respectively. But for the railway accident near Monywa, all might have escaped unscathed ; in this accident, in which both civil and military personnel were involved, 11 Survey of India employees were killed and 1 hurt ; 8 of their family members were killed and 9 hurt. See Table G.

The march from the Chindwin across the hills to Manipur was a very arduous one and many were exhausted on arrival, due not only to the severe physical effort but also to shortage of food. They were cared for, where necessary, in the hospitals in Assam and eventually sent on leave to their homes.

8. No. 6 HQ. and Company were reconstituted and re-equipped at Ranchi under the orders of the Dy. Director of Survey, Eastern Army.

Civilian members of the Burma Survey Party were dispersed, after their leave, to various units of the Survey of India in India ; Party headquarters was set up, in nucleus form, at Dehra Dūn under the control ( part time ) of Mr. Murphy who laboured throughout the remainder of the war to straighten out accounts, submit the necessary claims for compensation and so on.

9. Except for the original fair drawings of the Burma one-inch maps, all records were lost. Lt.-Colonel Wright managed to get hold of an aircraft in which he stowed these drawings and got them to India, where they were invaluable ; without them, maps of Burma could never have been re-published as they were.

Triangulation and other records were buried in a remote Forest Rest House in the Maymyo vicinity, but up to 1946 had not been found. They were presumably either found and used by the Japs or looted by local villagers.

In the result, a re-triangulation of Burma becomes necessary except in respect of primary triangulation of which the records remained in the Geodetic Branch of the Survey of India at Dehra Dūn.

10. Detailed reports up to 30th September 1941 are contained in the General Report of the Survey of India for 1940 and 1941.

## CADRES

The Survey of India comprised a number of "Services" of which the sanctioned strength, or cadre, was laid down by the Government of India from time to time, such as the Class I Service, Class II Service and Upper Subordinate Service ; there were also certain posts, not specifically described as a "Service", of which the numbers were controlled by the Government of India such as Division II Draftsmen's posts. The strength of the Lower Subordinate Service ( surveyors, draftsmen, etc. ) and of certain other collections of posts were not fixed by the Government of India but fluctuated according to the work in hand. An outline of the various "Services" is in Table A.

Within the Class I Service was a fixed cadre of posts to be held by military officers of the regular army, roughly in the proportion of three R.E. officers to one officer of the Indian Army.

Within the Lower Subordinate Service was a number of soldiers ( "Soldier Surveyors" ) who, though permanently in the Survey of India, still had military commitments as had the military officers of the Class I Service.

2. With the expansion of the Survey of India's role of *Base Organization* in 1942, the need for special ( war ) military cadres became urgent. The installation of considerable quantities of modern high speed automatic printing machinery, with which our men were unfamiliar, necessitated the attachment to us of British technicians ; these were army personnel and could neither be demobilized into civil posts ( which would have had to be specially

created) nor could they be posted to any existing cadre in the Department. It was essential that they should work directly under the control of the Survey of India.

A "B.O.R. Cadre" was therefore sanctioned by the Government of India, its strength gradually increasing as more and more machinery was installed to cope with the increasing work as the Eastern Theatre expanded. At the close of the war, the strength was 72 B.O.R.'s.

3. B.O.R. Cadre.—The men forming this cadre were at the outset highly skilled civilian technicians in the British lithographic trade who had been brought into the British army; in the latter part of the war, less experienced and skilled men who had been trained in army schools in U.K. were brought in. Throughout the war, however, there were sufficient skilled men, the W.O.'s and senior N.C.O.'s of the Cadre, to maintain high efficiency in map production and to train our own Indian personnel in the use of modern machinery.

Individuals in the Cadre changed frequently, because the policy was to use it as a pool for forming and maintaining military map publication units; as new units were formed or old ones required replacement of casualties, men were transferred out of the Survey of India Cadre and replaced in it by fresh drafts from U.K.

This system worked well; it gave fresh drafts from U.K. experience of work under tropical conditions before being posted to military units while at the same time preventing the boredom and slacking off that might well have occurred if the original men had remained throughout the war in the Survey of India. Fresh drafts usually also brought with them the latest ideas in vogue in U.K. or other theatres, which were of considerable value to us. See *Map Publication*.

4. The B.O.R.'s were employed partly in Calcutta and partly in Dehra Dūn at the outset; at the end, all were in Dehra Dūn the majority working in the new Hāthibarkala offices, the remainder in the Geodetic Branch offices. For long, those in Dehra Dūn had to live in tents in the Geodetic Branch compound. Eventually, we were able to have barracks built close by.

There was little sickness and the men accepted the conditions we were able to give them very cheerfully. Without this cadre, we could not have produced more than a very small fraction of the maps we did produce, see Table J.

The cost of the cadre was paid in full by the Survey of India. In the latter part of the war, B.O.R.'s awaiting posting from the Survey Depot (also in Dehra Dūn) to military units helped out in the Survey of India offices. The cost of these men was met by the army. See *Map Sales*.

5. Officers' Cadres.—There were, in effect, two (war) officers' cadres created of which one was paid for by the Survey of India, the other by the army; and in addition, an Indian Officers' (V.C.O.'s)



cadre, paid for by the Survey of India. The two former got somewhat mixed up from time to time but the reasons for them remained quite clear.

British officers had of necessity to accompany and control the B.O.R.'s Cadre ; these officers too were technicians of very high calibre in the British lithographic trade. In addition to accommodating them in the Department by some means or other, it was necessary to accommodate our own officers, civil officers who had been granted emergency commissions in the I.E., who were from time to time specially needed to reinforce the Department or who were awaiting postings but for whom no post existed in the Department unless they were demobilized ( and again mobilized when again required by the army ) a very tiresome and cumbersome procedure creating much work for everyone. A cadre ( temporary ) of military officers was therefore created to accommodate cases of this sort ; that is, military officers attached for *duty* to the Department. It varied in strength and sanctioned ranks from time to time according to circumstances and contained British technical ( map publication ) officers, officers required to operate our stores organization or to maintain our plant, militarized Survey of India officers temporarily required as training instructors, etc.

The Indian Officers ( Viceroy's Commissioned ) Cadre was formed on the same lines and for the same reasons.

6. The other Officers Cadre was purely a *training* cadre. Its strength too varied from time to time according to the immediate military necessity and its purpose was to accommodate emergency commissioned officers of the R.E. or I.E. or I.A. who were attached for training in survey duties pending posting to military survey units. Besides a limit on numbers, the sanction for this cadre also imposed a restriction on the time that any one officer might remain in it.

Likely officers of other arms than Engineers, and Engineer officers who had not had survey training as such but who were likely to make survey officers, were accommodated in this cadre while under training with us.

7. These arrangements, once they had been established worked out well enough without too much trouble to any concerned. In the one or two instances, before these cadres had been created, of having to demobilize officers and soon afterwards re-mobilize them there was untold correspondence and difficulty, and great delay in officers receiving their pay and allowances. The temporary cadre system prevented this, because officers did not change accounting systems while attached to us and though continuing to be paid from military sources were definitely under our control for work. The Survey of India was billed by the army for the cost of officers attached to it for duty, not for those attached for training.

8. Soldier surveyors recruited during the war, who were not as in the past members of the Department but were trained by it, did

not have a cadre like those described above. The difference was that vacancies caused in the war establishments of units and corps from which men were posted to Survey of India cadres could be filled; the soldier surveyors' vacancies could not be filled in their own units until they had been definitely transferred to the Corps of Indian Engineers. See *Soldier Surveyors*.

9. As regards leave and repatriation of British Service personnel. see *Lilop* and *Python*.

## CAIRO CONFERENCE, 1940

See Chapter V 58, 59 and *Conferences*.

## CAMOUFLAGE PHOTOGRAPHS

One of the duties of the photographic aircraft chartered by the Survey of India was to take photographs where needed by the armed forces ( in India, outside battle areas ) to test the camouflage of aerodromes, buildings, etc. This had the effect of relieving R.A.F. aircraft for operational duties. See *Indian Air Survey and Transport*.

## CANTONMENTS PARTY

No. 20 ( Cantonments ) Party had been reduced to Detachment status some years before the war; it was raised again to Party status as its work greatly increased during the war. Towards the end of the war it became one of our biggest parties and one that was very difficult of control due to the nature of its work, which required it to operate in small detachments scattered about India.

2. In the field seasons of 1939-40 and 1940-41 this unit had been carrying out routine surveys and re-surveys of cantonments following a 5-year programme laid down in consultation with the Engineer-in-Chief and the Defence Department of the Government of India; its annual expenditure was limited to Rs. 75,000 and its personnel consisted mainly of elderly surveyors, too old for the rough and tumble of topographical surveying, on the other hand thoroughly experienced and trustworthy so that they could work individually without too much supervision; there were a few traversers, levellers and computers.

Later, when the party had greatly expanded ( its budget for 1945-46 was 4½ lakhs of rupees ), these older men were very valuable in charge of small detachments, experienced officers being in very short supply.

3. Towards the end of 1941 demands for large scale surveys other than actual cantonments began to appear and by the spring of 1942 it became obvious not only that such demands would

become very heavy but also that it was futile to continue routine surveys of existing cantonments, altering almost daily as they were by then. The routine programme was therefore broken off as quickly as was consistent with reasonable economy and thereafter the party carried out whatever works were demanded from time to time by the E.in-C.s Branch in connection with airfields, factories, cantonment extensions, prisoners of war camps, etc., etc. A lot of this work was carried out in areas close to the battle area ( see *Assam* and *Bengal* ) and also in the area of Southern Army. It was, however, scattered all over India and was very difficult of control both technically and administratively.

For instance, in 1942-43 surveys were carried out in more than 50 different localities in India; in some of these localities there was more than one separate survey.

4. At the outset, detachments of the party were placed at the disposal of the several Chief Engineers of the military commands, the strength allotted to each command being decided in consultation with the Engineer-in-Chief. Later on, when operational armies were established and military Deputy Directors of Survey were controlling survey work in each Army area, the detachments worked under the orders of the D.D.Svy. of the Army; in the remainder of India, the Engineer-in-Chief decided where detachments were to be employed.

Technical control was by the Director, Geodetic Branch to which branch of the Survey of India the party belonged; he was also responsible for administration and this became a very difficult and involved business. We were ourselves unable to assist much, if at all, in providing accommodation or rations, etc., for the various detachments who had to rely on the local military authorities taking them under their wing; treatment naturally varied according to the circumstances in each area and there was some dissatisfaction among men working alongside other men of their own unit who happened to be receiving more advantageous treatment than they. It was hard to see how to avoid this, since our men were not civilians "in military employ" within the letter of the military regulations, and were not entitled to military rations or allowances.

A specific instance is mentioned in *Assam*, 4.

5. Works undertaken involved triangulation, traverse, levelling, plane-tableing and in some cases air survey, with the attendant computational and drawing work. All except air survey was done in No. 20 Party; in cases where air survey was involved, the work was done in No. 18 ( Air Survey ) Party at Murree. Some work was done entirely by the party, some in co-operation with personnel of the M.E.S. or with other survey personnel of the Survey of India or the military survey service.

6. The full cost of this unit was met from defence estimates.

## CASUALTIES

There were few war casualties to Survey of India personnel and their families. See *Burma Survey Party 2*, 7. None resulted from the bombing of Calcutta by the Japs or during the communal riots that occurred in 1942 and 1945. Some injuries were sustained in a fire that occurred near Ledo ( Assam ) in 1943.

The sickness rate in the civil Department was low though tending to increase in the later years of the war due to curtailment of leave and not fully adequate nutrition ; ailments were mostly minor, there being no epidemics. See *Health*.

“Casualties” in the technical sense did of course occur due to age ; a factor in this was, however, the short recruitment during the 1914-18 war and the retrenchment of 1931-32, resulting in abnormally low numbers of superannuations. Details are in Table G.

## CERTIFICATE OF HONOUR

With the approval of the Government of India, the Surveyor General was accustomed to award Certificates of Honour to Upper Subordinate Officers and senior surveyors, etc., who had particularly distinguished themselves on survey and related duties with military forces. This practice was continued during the 1939-45 war and in addition a “junior” form of award, called Commendation Certificate, was introduced. See Table F.

## CENTRAL MAP DEPOT

See *Map Depots*.

## CEYLON

Ceylon had its own Survey Department and published its own maps ; India, however, published 1/1,000,000 and 1/2,000,000 scale maps that covered it.

As with other neighbouring countries, material was exchanged between India and Ceylon so that certain maps could be printed in either place in emergency, and the Ceylon map publishing offices helped out by dealing with some of our printing rushes.

2. There had been little liaison between the two countries before the war. During the war, however, liaison was much closer and the Director of Survey ( India ) visited the Ceylon Survey on several occasions.

The Ceylon Survey Department printed three 1/M ground/air ( Hind 5000 ) sheets, N B-44, N C-44 and N E-45, the first being from their own material and the two latter from the latest chromo pulls supplied by India. The Survey of India printed 58 one-inch sheets of Ceylon during 1942.

3. A considerable number of Survey of India personnel served in Ceylon during the war after Kandy became the headquarters of the Supreme Allied Commander, South-East Asia. During 1944 and 1945 military mapping, reproduction and survey units manned mainly by Survey of India personnel were transferred to Ceylon and in July 1945 the headquarters of Allied Land Forces, South-East Asia also went to Kandy.

Certain members of the Ceylon Survey Department served in military survey units in SEAC, Major G. B. King in particular doing very valuable work.

## CHANDA

A *chānda* is a mark-stone or post used to indicate a change of direction in a field, etc., boundary.

## CHARTER

Certain aircraft were chartered for survey work during the war, see *Indian Air Survey and Transport Ltd.*

## CHIEF DRAFTSMAN

The term "Chief Draftsman" as used in the Survey of India was really a misnomer, the duties of this officer being of a staff nature ; in fact he was practically Assistant Director, Map Publication and though he remained in the Class II Service he drew an allowance of Rs. 150 per month. It was the Head Draftsman ( in No. 1, the headquarters, Drawing Office ) who was supposed to be the current expert on drawing rules and regulations.

The Chief Draftsman's main task was organizing material for publication.

2. During the war, when publication very greatly increased, it was necessary not only to increase the number of chief draftsmen but also to create higher ( Class I service ) posts which were called Assistant Directors, Map Publication. The term "Chief Draftsman" was retained in respect of Class II Service assistants.

Eventually there were, in addition to various assistant directors, four posts of senior chief draftsmen receiving Rs. 100 per month special allowance and four of junior chief draftsmen receiving Rs. 50 per month.

## CHINA

Though called upon from time to time to produce maps of China, our information about that country was meagre and we found some difficulty in obtaining maps on which to base even such small scale publications as our 1/1 million scale series.

Visits to western China were made by two officers in connection with maps and routes but produced little material on which to base necessary maps.

2. A number of Chinese army officers were given courses of various lengths in the Survey of India of which one went through our full training course in triangulation, plane-tableing and connected subjects.

These officers included :—Major-General Lien Tien-Chang, Colonel Ku Chen-Ching, Major W. S. Liu, Major Tang Cheu Hsien, Major Wu Chun Siang, Captain Shen Ching-Siang, Captain Chen Siang, and Lt. Wong.

3. Language difficulties presented some teaching problems but our Indian instructors were very clever indeed at conveying their meaning to the trainees.

## CIRCLES

Prior to the retrenchment of 1932, the Survey of India was organized in "Circles" of which five were territorial for convenience of administration (Frontier, Central, Southern, Eastern and Burma) and two were centralized for convenience in special work (Geodetic Branch at Dehra Dūn and Map Publication Office at Calcutta). Each was controlled and administrated by a director.

In 1932, the Central Circle disappeared, the Southern Circle was reduced to one "Independent Party" and similarly in Burma. During the war, both these independent parties also disappeared, the former being reduced to detachment status and the later, upon the evacuation of Burma, absorbed in other circles in India; on the other hand, other circles were created. The various circles and independent parties are described under their various names, see *Burma Survey Party, Eastern Circle, Frontier Circle, Geodetic Branch, Military Circle, South India Party, War Research Institute*.

2. With the expansion of the Department soon after the war, to cater for reconstruction surveys, the Southern Circle was resuscitated; this had been dissolved during the retrenchment of 1931-32.

Deputy Directors' posts were also created for some Circles during the war and continued after the war. These posts had not hitherto existed.

## CIVIL ACTIVITIES REPORT

Regular Survey of India Reports were suspended after 1941. Very brief reports outlining civil activities during the war were published in 1945 and 1946, see *Reports and Returns*.

## CIVIL AVIATION

The Director of Civil Aviation was instrumental in making the Survey of India charter with Messrs. Indian Air Survey and Transport Ltd. possible by his assistance in obtaining spare parts and

eventually new aircraft for the company, and by granting them special facilities on airfields, etc.

2. *Aeronautical charts* proposed to be introduced are briefly discussed under that heading.

The International Air Convention in 1944 also involved the Survey of India in very heavy work just when it could least afford the time, in the examination of symbols for charts and somewhat controversial and ambiguous instructions for mapping procedure proposed to be internationally adopted.

## CIVIL WORK

Civil survey and map publication work was gradually broken off as war work supervened; towards the end of the war it was gradually increased again as reconstruction projects began to take shape.

There is more detail under *Projects*.

2. Map issues to civil indentors represented about 80% of our total issues during 1938-39; during 1942-43 they represented about 7½% . (Table J).

## CLASS I SERVICE

The Class I Service of the Survey of India consisted of about 32 military officers in the proportion, roughly, of 3 R.E. officers to one I.A. officer, plus 5 posts reserved for civilian officers promoted from the Class II Service.

During the war, more than half our strength of military officers was in military employ and extra posts in the Class I Service were created. All these vacancies were filled by officers promoted from Class II, in a number of cases by re-employed officers. Direct recruitment to this service was stopped during the war. The service was completely reorganized after the war.

Details appear under the appropriate headings such as *Cadres, Training, Promotion*. See also *General Central Service* and Tables A & B.

## CLASS II SERVICE

The Class II Service consisted of civilians recruited through the Public Service Commission from university graduates or persons of equivalent educational standing. Recruitment was in accordance with a communal roster prepared by the Government of India.

Some vacancies were reserved for promotion from the Upper Subordinate Service.

The Class II Service is a "gazetted" service; the U.S.S. is not. See Table A.

2. In peace time, recruitment to this service had been every second year and as a rule only 2 or 3 vacancies were available.

During the war, recruitment became annual and up to 20 vacancies became available as our need for officers increased.

*Training* thus presented a problem. There are more details under this and other appropriate headings.

3. Officers of the Class II Service received commissions on joining the army ; rank was based on length of service in the Survey of India. Commissions were normally in the Corps of Royal Indian Engineers ( E.C. ).

This is further discussed under *Terms of Services* and Table B. See also *General Central Service*.

## CLASS III SERVICE

This service is a new departure, introduced after the war, as also the Class IV service. The reason for introducing these nomenclatures was the confusion and difficulty caused in other Government of India offices who did not understand our special terms of Upper Subordinate Service, Lower Subordinate Service and Inferior Service.

Class III and Class IV services are not referred to as such in this book, see *Lower Subordinate Service*, *Upper Subordinate Service*, *Inferior Service*.

## CLERICAL STAFF

The clerical staff of the Surveyor General's Office and the Calcutta offices were on terms of service somewhat similar to those in the Government Secretariat Attached Offices, with a probationary period followed by permanency in a definite vacancy and grade. Pay was on fixed time scales laid down by the Government of India.

These clerks were not posted to the Topographical Circles of the Department but served throughout their time in the "Headquarter Offices".

2. The Geodetic Branch and Topographical Circles, however, utilized clerks recruited into and serving under the terms of service of the Lower Subordinate Service, except that the Head Clerks and Head Accountants of circles were on special terms ; promotion to these latter posts was into vacancies only, unlike the Lower Subordinate Service where no fixed strength for any rank was laid down, promotions being made as individuals attained necessary experience and merit.

3. During the war, recruitment was continued on both lines indicated above but towards its end we were trying to amalgamate all clerical services so that clerks would be interchangeable between field and "headquarter" offices. With the shortage of trained clerks for expansion during the war, the lack of knowledge of "headquarter" clerks of field procedure, and vice versa, proved a considerable handicap. To obviate this, a considerable number of "field" clerks had tours of duty in the Surveyor General's Office.



It will be seen from Table C that by 1945, 91 clerks and store-keepers of the Survey of India were serving in military headquarters and units. See also *Lower Subordinate Service, Surveyor General's Office, Administration*.

## COLOURS ON MAPS

Maps had been printed in multiple colours before the war. During the war, policy fluctuated from black and brown only ( or even all black ) to multiple colours according to circumstances.

Mention is made in Chapter III 35-37 of reasons leading to changes in policy and also in *Map Policy*.

## COMMENDATION CERTIFICATES

See *Certificates of Honour* and Table F.

## COMMITTEE ( 1905 )

See Chapter I and *Map Policy*.

## COMPILED MAPS

These are maps that are built up into a composite whole from fragmentary maps on different scales, or that are assembled on a small scale from several maps of a series on a larger scale.

Much compilation work is required, for instance, in building up a standard 1/1 million scale map of ( say ) French Indo-China. During the war, some of this work was done wholly by the Survey of India, some wholly by the military survey service and some in co-operation between the two. See *Fair-drawing*.

## COMPUTATIONS AND COMPUTERS

Computations are not usually very heavy in a topographical survey unit and are comparatively simple, mainly for topographical triangulation and traverse. They are heavier and more complicated in air survey work except in its simplest form and may be heavy in certain cadastral work like settlement survey.

They may be very heavy and very complicated indeed in connection with geodetic and geophysical work.

2. Except in the Computing Office of the Geodetic Branch ( War Research Institute ) the Survey of India had few computers of high calibre before the war ; computations were usually carried out in recess where there was officer supervision readily available, or by officers themselves in the field. Our computers were often men who "doubled" in traversing or levelling during the field season, tasks which require little education to carry out in a routine way and consequently the standard of education among computers was not very high and there were few who could be trusted to work entirely alone or to "set up" computational work.

We were therefore hard put to it to obtain sufficient computational staff to man the military survey units as they were formed and to keep them up to strength in the field.

In the Geodetic Branch too, our computational strength was inadequate to cope with the very heavy work involved in the supply of trigonometrical data to the forces in the Eastern Theatre in which also some skill was required to co-ordinate the triangulations of different countries like Burma, Thailand and Indo-China. The setting up of new grid systems also called for computational ability of a higher standard than most of our men could achieve, besides being heavy in volume when grid tables were in the making. See *Grids*.

3. In 1941-42 an innovation was tried—that of recruiting university graduates who were required to have an honours degree in mathematics ; for lack of a better name, these were called “Temporary Computers”. Besides being taught computational work the majority were taught triangulation, traversing and levelling and also did some plane-tabling ; they were therefore equipped to work quite independently, once they had gained the necessary experience and sense of responsibility. It was found, however, that a good many disliked field work and would remain with us only in office jobs ; on the other hand, some made excellent all round officers and were very useful in the military units as well as in the Department. They did, in fact, serve to reinforce our Class II strength, having much the same qualifications though they were originally recruited in lieu of Upper Subordinates whose recruitment was stopped.

4. Because so many of the temporary computers were not interested in field work, a modification was later made in the system, stressing drawing ability and inclination for outside work in the recruiting requirements ; men so recruited were called “Topographical Assistants” and were required to go through a complete field course in one of the training parties, from which they were “weeded” if they showed too much liking for office work and either released altogether or, if their mathematics were up to it, transferred to purely computational work.

These men formed the backbone of computational strength in the military units towards the end of the war and in the Survey of India special parties for reconstruction and in the air survey party.

Temporary Computers who had not had full training in the field were given the option of taking the training and being reclassified as Topo. Assistants ( T.A.'s ) on a little higher pay, or of being released. A few temporary computers of more than average mathematical ability were retained in the Research Institute for specialized work. See *Topographical Assistants*.

5. The Computing Office itself, a part of the Computing and Tidal Party, was run by a Head Computer who was an officer of the Upper Subordinate Service. The Computing and Tidal Party had been commanded by a military officer and had on its strength the Mathematical Adviser to the Department, Mr. B. L. Gulatee, M.A. ( Cantab. ).

During the war, the two functions were combined, Mr. Gulatee being in charge of the Computing and Tidal Party practically throughout ; he later took over the Research Institute from Dr. Hunter on the latter's retirement.

Originally part of the Geodetic Branch, this party was transferred to the War Research Institute on formation.

6. Complex computations and computations requiring the equivalent of "mass production" were dealt with by the Computing Office, which possessed mathematical tables, computing machines and slide-rules of greater precision than those used by the field units and through numbers and ability of computers was better equipped for quick mass production of trig. data and similar tasks. See *Triangulation, Grids* and also *War Research Institute, Computing Machines*.

## COMPUTING MACHINES

Until about 1930, Survey of India computations were carried out almost entirely by using logarithm tables. As military training developed and the difficulty of getting computers to work quickly with logarithms became apparent machines were gradually introduced, the first being the small Brunsviga, a German made rotary machine, light and easy to learn.

By 1939, the Department possessed a considerable number of these small machines as well as one or two bigger ones by the same maker and one Brunsviga Twin ; a second Twin was made of two small machines in the Mathematical Instrument Office.

All computation forms necessary for any work likely to be undertaken on military service, including air survey forms, had been designed and published for machine (or slide-rule) computation, with complete instructions how to use them.

2. In war equipment tables framed in 1940, each Field Survey Company was supposed to have 5 computing machines ; there were not enough to go round in the Survey of India (that could be spared from computational work in Dehra Dūn for war purposes) and the Brunsviga being a German machine, we had to look elsewhere.

Agents for various computing machine firms were approached and eventually we were able to get a sufficient number of the American Marchant machine (semi-rotary) to satisfy the requirements of all military units.

3. Slide-rule computations were also utilized when possible and the use of this instrument taught to all officers likely to carry out supervisory duties.

Forms were designed to permit the use of the slide-rule in conjunction with the machine whenever its accuracy was sufficient.

## CONFERENCES

Conferences had been somewhat conspicuous by their absence in the Survey of India before the war though two or three big map conferences in the years immediately preceding it made important exceptions to the general rule and had an important bearing on the map policy of the Department when the war broke out. See *Map Policy*.

Tours too were usually made for the purpose of carrying out inspections, rather than for the purpose of discussion.

2. During the war, inspections were of course carried out but they were much more limited in scope and much more time had of necessity to be devoted to conferring, both to avoid delay and misunderstanding in correspondence—not to mention shortage of clerical staff to do all the typing involved in lengthy correspondence—and to apprise those in the outlying areas what was going on.

During the last few years of the war and early reconstruction, the Surveyor General held a regular monthly conference at Dehra Dūn where by this time four different circles were functioning. The one particular point that impressed me most at all these visits to Dehra Dūn was the misunderstandings that constantly arose because those in Dehra Dūn, more than fully occupied with their own tasks as they were, did not appreciate what lay behind apparently conflicting orders, delays in implementing decisions and so on. I found that a short summary of what went on in Delhi, the why and wherefore of delays or changes of plan, etc., did more in a few minutes to clear misunderstandings than months of correspondence could have done; indeed much of the information that was imparted was such that we would have had to have very bulky “secret” files. In passing, it may be said that we had no leakage of secret information throughout the war.

3. Major inter-service conferences connected with surveys and maps were held at Cairo in 1940 (India-Mid-east-War Office) and at Delhi in 1941 (India-Mid-east-Malaya). In these conferences the role of the Survey of India was worked out in relation to supply of units, training of personnel and map policy. See Chapter V 58, 59 and VI 74.

There were also numerous minor conferences in connection with war matters for deciding policy of more local interest, including one dealing with the post-war survey organization in Burma; and one of some importance relating to the post-war use of the vast quantity of map publication plant installed in the Department, see *Information and Broadcasting Department*.

After the G.S.G.S. was fully functioning, the Survey of India had less to do with war map policy decisions and conferences between the Department and its military counterpart were mainly in respect of what could or could not be done, and how to do it. The Director of Survey or one of his staff officers made frequent visits to Dehra Dūn to confer with Survey of India officers about this and

they too were of the utmost value in removing misunderstandings and expediting work.

## CONFIDENTIAL REPORTS

See *Documents*.

## COSTS

In peace time it had been customary to work out cost-rates for surveys carried out. They could give only a very vague picture however, on account of the very wide divergence in relevant factors between surveys under different conditions of terrain, personnel available, etc. They were discontinued in the war and the cost of any surveys undertaken on a payment basis estimated on the facts at the time.

There had also been fixed rates at which map publication was undertaken on payment. These too were useless under the fluctuating conditions of the war; it was in fact almost impossible to come to any definite cost rates for works because so much of our equipment was issued without payment by us and so many of the stores used were unpriced, having been supplied direct from U.K. military sources.

Except maps, services as between ourselves and the military survey service were therefore not charged for. In the case of maps, arbitrary rates were fixed for budgetting purposes. These are discussed under *Map Sales*.

## DECLINATION (MAGNETIC)

Reasons for the supersession of "declination" by "variation" on Survey of India maps are given under *Magnetic Work*.

## DELHI CONFERENCE (1941)

See Chapter VI 74 and *Conferences*.

## DEMOBILIZATION

Up to 1946 few units as such had been demobilized, though many individuals had returned to civil duty or had been discharged from the army, some at the same time taking their discharge from the Survey of India. See *Military Survey Units*.

Demobilization was carried out by the Survey Depot (which was also the civil survey depot) at Dehra Dūn. This unit held both military and civil documents of personnel which made the transition from military back to civil easy, and also civil discharge in the case of those who wanted it.

The work of this unit is described more fully in the headings *Mobilization* and *Survey Depot*.

2. War leave and travelling allowances presented considerable problems in connection with demobilization since two sets of rules, military and civil, were involved having different definitions of "headquarters" and different scales for travelling concessions. Furthermore, many of our men who by their military rank were entitled to travel (for instance) second class, were by civil rules entitled only to inter class. Much juggling had to be done to prevent grievances and short handed as we were to make use of men immediately they were released by the army. A scheme for "deferred leave" was eventually introduced which helped considerably on the latter point. See *Leave*.

## DEPOTS

See *Map Depots, Survey Depot*.

## DEPUTY DIRECTORS

There had been no posts of Deputy Directors in the Survey of India before the war. The enlargement of some circles during the war and the diversity of their work made the creation of Deputy Directors' posts necessary from time to time. These were temporary posts, sanctioned each year by the Government of India. A number of such posts was sanctioned as a "permanent" measure after the war, for reconstruction work.

Deputy Directors received the time-scale pay of Superintendents, plus a special allowance. In the case of very senior officers, this brought them up practically to the minimum pay of a Director. In one case the anomaly occurred of a Deputy drawing more pay than his Director. In several cases, "war allowance" operated to create anomalies. See *War Allowance*.

2. The military post of Deputy Director carried with it a definite rank and pay anomalies that were unavoidable under civil procedure did not occur. On the other hand, the military system made appointments more difficult to work out, if anomalies in military *vis-à-vis* civil rank were to be avoided.

## DIRECTOR OF PLANNING (MAPS). D.P.M.

See *Map Publication*.

## DIRECTOR OF SURVEY (INDIA)

The Director of Survey (India) was the head of the military survey service and also of the Geographical Section, General Staff, in India. Under the organization followed throughout the war, he was also a Director in the Survey of India. This is discussed in some detail under *Military Organization*.

There were other Directors of Survey heading the military survey organizations in various theatres, such as SEAC., Mid-east, etc.

## DIRECTORS, SURVEY OF INDIA

Directors of the Survey of India head the various circles of the Department and are sometimes referred to as "administrative officers". They are not automatically granted the military rank of Colonel though to qualify for that rank a military officer in the Survey of India must be a substantive director in the Department. When officers of lower military rank were officiating as directors, there was sometimes confusion on this score. See *Promotions*.

## DISCIPLINE

There were few serious disciplinary cases to contend with. So far as the Survey of India as a whole was concerned, the major difficulty lay in the relation between military law and civil law as codified in the various civil regulations, in particular the Classification, Control and Appeal Rules which govern the conduct of civil servants, the punishments that may be awarded them and their recourse in the form of appeal. It was always a moot point whether military personnel employed in the Survey of India came under military or civil law for punishment and equally whether they possessed any military "power of command" over other military personnel in the Survey of India who were their juniors in military rank. Officers and other ranks attached for training still further complicated the problem, except that in their case they had a definite military commander to whom any disciplinary case could be referred.

Fortunately, few cases occurred that made it necessary to "test" the somewhat difficult procedure. In the case of soldier surveyors, not members of the Survey of India, military officers responsible for their training were given powers under military law ; but in the few cases sufficiently serious to call for court-martial, the situation was not free from difficulty.

2. So far as the civil personnel of the Department was concerned, the Classification, Control and Appeal Rules provided all necessary authority and guidance but were sometimes not sufficiently studied by those inflicting punishments, or ( even further back ) by those who thought it necessary to punish though not having the power to do so themselves. In a number of cases, sentences had to be revoked on appeal, in almost every case because the original charge had been incorrectly framed. For instance, in one important case involving in the end a very great many pages of evidence and explanation, the charge was disobedience of an order. I could not find that an *order* had ever been issued and hence had to revoke the punishment that had been inflicted by the competent authority. I was, however, able to inflict a "punishment" more suited to the crime which though far less severe than that originally inflicted was more telling and prevented other appeals in the same case that I knew were being held up pending the result of the first one.

This case is instanced only as a rough guide towards avoiding the pitfalls that must occur if much thought is not given, at the

outset, to disciplinary cases and as a corollary towards giving the fairest possible treatment in such cases.

## DIVISIONS II AND III

See *Cadres, Upper Subordinate Service, Lower Subordinate Service.*

## DOCUMENTS (PERSONAL)

Personal documents are normally held in the unit in which the individual is serving ; copies of confidential reports on all officers down to and including Upper Subordinates and Division II Draftsmen and map publication personnel are held in the Surveyor General's office. These are so drawn up that they form a record of an individual's technical service as well as of his conduct and character. They are the Surveyor General's guide in making postings and promotions.

During the war the personal civil documents of mobilized personnel were held in the Survey Depot along with their military documents. This much assisted in mobilizing and demobilizing. See *Survey Depot.*

2. Some difficulty was experienced in connection with confidential reports. At the outset, reports on mobilized officers continued to be submitted by Officers Comdg. units to the Surveyor General through their Director of Survey, as usual. Later on, the army objected to this procedure and also objected to sending us copies of the military reports—indeed the latter were discontinued, except when specially called for. It would, in any case, have been difficult to continue normal procedure as soon as units began to be commanded by non-Survey of India officers.

The result was lack of continuity in information about officers, in the most important years of their careers perhaps, and the Surveyor General had great difficulty in deciding on civil promotions ; such promotions in most cases also carried military promotion under our terms of service.

The army eventually agreed to give us special reports on individuals likely to be promoted and this helped very greatly. The lack of continuity in recording technical employment is, however, likely to cause difficulty later on when officers, junior now, come up for promotion to Class II or Class I service. This will be mitigated to some extent by records kept in the *Military Circle.*

## DOCUMENTS (SECRET)

The Survey of India followed normal military procedure in the classification and handling of secret and similar documents.



## DRAWING AND DRAFTSMEN

The Survey of India uses the spelling shown, in preference to the older spelling "draughtsmen".

Except in No. 1 Drawing Office in Calcutta ( the headquarters drawing office ) and to a less extent in No. 2 Drawing Office in the Geodetic Branch, few draftsmen were normally recruited as such in the Department. All plane-tables had of necessity to be taught drawing as part of their work and these men carried out the greater part of the fair-drawing work in their topographical parties, during the recess season when it was too hot to work in the field. Surveyors too old to take the field but who were good draftsmen were usually retained on office work in the drawing offices all the year round and sometimes "reclassified" as draftsmen.

2. The war caused a large number of surveyors to be militarized while at the same time causing a great increase in the demand for new maps and hence drawing. We were therefore very short indeed of drawing power. Although it does not take very long to train a man to draw reasonably well, it takes many years to teach him to draw intelligently, following the rules and regulations for maps. This resulted in many maps perforce departing from Departmental standards of accuracy and legibility and greatly increased the task of the experienced officers, also in short supply, responsible for their "examination"; that is, responsible for checking accuracy and legibility.

This was a vicious circle that we found it hard to square while at the same time providing the number of draftsmen for the army that were called for by war establishments.

It has been said in connection with air survey that our air surveyors had been taught all steps in the simple radial line process. It follows that the Department used surveyors, not draftsmen, for its air survey work; it is essential that the air surveyor know what a contour is and this can best be learnt on the ground.

3. There is more about the technique of drawing under *Fair-drawing* and about *Training* under that heading. The functions of the *Chief Draftsman* are explained under that heading. British draughtsmen are referred to under *Army Section* and *G.S.G.S.*

## DRAWING OFFICES

Each circle headquarters normally included a drawing office of size and constitution designed to meet the needs of the particular circle. The functions were primarily compiled mapping and map examination.

### No. 1 DRAWING OFFICE

In the headquarters offices in Calcutta, it remained in Calcutta throughout the war though many of its personnel were transferred

to Dehra Dūn ( Hāthibarkala ) when the new publication offices were established at that place, being replaced by men recruited locally.

This office contained mainly draftsmen, few surveyors, and had some exceptionally skilled men well versed in compilation and small scale map work.

## No. 2 DRAWING OFFICE

In the Geodetic Branch at Dehra Dūn where it remained throughout the war, considerably augmented. This office had a few specially skilled men and had much experience of compilation of ex-India surveys of an exploratory nature, and held the records of these surveys. A considerable amount of compilation work was done in this office in respect of maps of Siam, French Indo-China, etc.

## No. 5 DRAWING OFFICE

In the Eastern Circle, it was transferred with the circle from Shillong to Dehra Dūn early in the war. A topographical office with much experience of topographical drawing and compilation to quarter-inch scale. Composed to a considerable extent of surveyors, it lost a good number to military units or as instructors in plane-tableing in the Survey of India training units. It was therefore made responsible for the recruitment and training of draftsmen required by the military units while at the same time keeping up its own strength during the training process.

See *Eastern Circle*.

## No. 6 DRAWING OFFICE

In the Frontier Circle, it had had considerable experience of military requirements as well as normal topographical requirements. See also *Army Section, No. 6 D.O.*

This office continued to function in Simla until the Frontier Circle headquarters was transferred to Murree and Simla vacated by the Survey of India ( see *Frontier Circle* ). No. 6 D.O. then moved to Dehra Dūn where it reinforced the Eastern Circle ; when the new publication offices at Hāthibarkala came into full operation, No. 6 became its drawing office.

The Frontier Circle was without a drawing office, as such, for the latter part of the war. One of its parties was however used in that capacity.

## EASTERN ARMY

This army replaced Eastern Command ( India ) in 1942 when the Japanese threat to India developed. It later became 14th Army and eventually part of 11 Army Group and finally of ALF SEA both under the control of SEAC.

Colonel G. Bomford, O.B.E. was appointed Deputy Director in charge of this army Survey Directorate on his return from South-west Pacific Command in 1942 and remained in this post till the end of the Burma Campaign, and was under the control of the Director of Survey ( India ) till the formation of SEAC.

## EASTERN CIRCLE

The Eastern Circle consisted of Nos. 4, 5 and 12 topographical parties and No. 5 Drawing Office, with headquarters at Shillong ( Assam ), and before the war was engaged in a topographical survey programme in Assam, Bengal, the eastern part of the United Provinces and the north-eastern part of the Central Provinces and neighbouring Indian States areas.

The work was unimportant from a war point of view at least at that time and the circle represented a large drawing potential ; it was therefore transferred *en bloc* to Dehra Dūn ( 1940-41 ) where offices were found for it partly by hiring, partly by the public spirited action of the ex-Maharaja of Nābha, who made a large building available rent free subject to our maintaining it.

The offices vacated in Shillong were loaned to the army and for a good part of the war were used as a hospital ; later, they were used as headquarters for various military formations.

The circle returned to Shillong, more or less in nucleus, in 1946 using the offices partly for residential accommodation, then very short in Shillong.

2. For most of the war, this circle was in effect a large drawing office and its director was charged with the duties of organizing most of the drawing work of the Department and recruiting and training new draftsmen.

No. 12 Party, however, took the field in Assam for very important work ( see *Assam* ) and the circle formed the Perso-Baluch Party for urgent work in co-operation with No. 3 Indian Field Survey Company in Baluchistān and Eastern Irān, see *Baluchistān*.

A detachment was also formed to carry out the Kurram Settlement work ( see *Hazāra* ) and a small detachment carried out the revision of the Delhi Guide Map that was in great demand in the later part of the war.

3. At the end of the war, as reconstruction work increased and military drawing work diminished the Eastern Circle gradually altered to a "Projects" circle. See *Projects Officer*. Eventually it distributed this centralized projects work to the various territorial circles concerned and itself concentrated on projects work in eastern India, notably the Tista, Kosi, Dāmodar, Karnaphuli and Mahānadi irrigation and flood control works.

4. Soon after arriving in Dehra Dūn, the Eastern Circle was further reinforced in drawing power by the bulk of the South India Party, from Bangalore. See *South India Party*. The latter unit was eventually reformed as part of the Southern Circle.

## “E” COMPANY

On the formation of the Frontier Circle in 1925, Nos. 2 and 3 Parties of the old Northern Circle were transferred to it and renamed “E” and “A” Companies with headquarters respectively of Quetta and Murree. These two units were intended to be the nuclei for the mobilization of survey companies for war and a gap in company lettering was left to allow for expansion to eight companies, “A” to “H” inclusive. In the event, the lettering system was dropped and though we agreed to provide eight Indian Field Survey Companies, we eventually provided only seven, on the other hand providing a large number of smaller units such as Map Supply Sections that had not been allowed for at the outset.

A considerable amount of military training, staff exercises and “Tactical Exercises without Troops” had been carried out by “E” Company in Quetta, in co-operation with Western Command; a lesser amount by “A” Company in co-operation with Northern Command, until 1938-1939 when comprehensive training was undertaken both Departmentally and in co-operation with the R.A. Survey Section.

2. At the outset of the war, “E” Company was based on Karāchi. Soon after, it was moved to Murree/Risālpur and amalgamated with “A”—which by this time had become more or less a normal topographical party—under the name “A and E” Companies (later “A/E” Party) and finally these units became Nos. 3 and 2 Parties respectively as they had originally been before the creation of Frontier Circle.

Neither unit was used as a mobilization nucleus as such. This task devolved on No. 18 (Air Survey) Party and the Survey Depot, established at Risālpur soon after the outbreak of war.

The mobilization stores of both units had been concentrated at Risālpur under the charge of No. 18 Party and “E” Company’s rotary printing machine had been taken over by No. 18 Party.

See also *Air Survey Party* and *Frontier Circle*.

## EDUCATION, HEALTH AND LANDS DEPARTMENT

The Survey of India came under the control of this department of the Government of India when it superseded the Revenue and Agriculture Department in 1923; it remained under its control practically throughout the war, coming under the Department of Agriculture when E.H. & L. split up into three in 1945. (Education; Health; Agriculture). This was logical for by this time irrigation and similar works were coming very much to the fore, most of them connected with agriculture.

2. The officers of the Department of E.H. & L. with whom the Survey of India had most contact were Messrs. Tyson and Oulsnam, I.C.S. (later Sir John Tyson, K.C.I.E., C.S.I., C.B.E. and

Sir Samuel Oulsnam, C.S.I., C.I.E., M.C.), particularly the latter. The Survey of India and also the military survey service in India owe a great deal to these two officers.

## ELECTRICAL EQUIPMENT

*See Plant and Machinery.*

## EMERGENCY COMMISSIONED OFFICERS (E.C.O's.)

All civil officers of the Department granted commissions received Emergency Commissions and a number of other E.C.O's. were trained in the Survey of India and posted to military survey units. Some E.C.O.'s also were posted direct to Indian Companies and other units, from U.K.

*See Terms of Service and Training.*

## ENEMY PRISONERS OF WAR

Arrangements were made with the army to secure the services of a few Italian co-operator P.W. who were surveyors and draftsmen by profession. These officers were very useful in furthering civil surveys, see *Air Survey, Afghānistān, and Projects*. They were not employed on military work. There was some difficulty at first about food, etc., but this was smoothed out.

## ENGINEER-IN-CHIEF

The Engineer-in-Chief was the senior officer of the Royal Engineers in India and of the Royal Indian Engineers. As, however, the Survey of India was a civil department under the Government of India and the military survey service came under the orders of the General Staff, our connection with the E.-in-C. was mainly in respect of surveys that he desired to be carried out.

These have been mentioned under *Cantonment Party*.

2. Apart from actual survey work, we were able to give the E.-in-C. some assistance in setting up survey courses in the newly formed School of Military Engineering at Roorkee and came to a tentative agreement about the training of R.I.E. officers in survey duties in the field, after the war.

3. The E.-in-C. kindly provided us with a Works Officer to assist in maintaining the buildings in the Hāthibarkala map publication offices and to organize transport for hauling machinery, etc., to the buildings and maps away from them. See *Hāthibarkala*.

## ENGINEER OFFICERS

Regular officers of both the Royal Engineers and the Royal Indian Engineers were included in the permanent military cadre of the Survey of India.

Emergency commissioned officers of both Corps were also attached for duty or for training, and our civil officers received emergency commissions in the Royal Indian Engineers ( but for one exception, commissioned in the Royal Engineers ).

More will be found under appropriate headings such as *Cadres*, *Training*, etc.

## ENGINEERING SURVEYS

These were mostly in connection with irrigation projects or airfield, factory and similar works. See *Projects* and *Cantonment Party*.

## ENGRAVING OFFICE

This office formed a part of the headquarter offices at Calcutta and remained there throughout the war. It comprised a Head Engraver, Assistant Head Engraver and about 30 engraving and copper plate printing staff. The standard of work was, and is, very high and it takes a very long time to train men up to this standard—in most cases the skill is handed down from father to son.

Though there was little this office could do to assist directly in the war effort we were most reluctant to dissolve it or to dissipate its trained and highly skilled personnel. Just before the war, it had been decided to revert to engraving for all 1/1 Million scale maps ; this policy was continued for the war and a considerable number of 1/M maps were put on copper during its currency.

## EQUIPMENT

Military equipment was obtained for mobilization store, and by mobilized units, from the Ordnance Department following usual military procedure.

Special surveying equipment was supplied in part by the Survey of India and in part by the British Survey Service ; this is dealt with under *Instruments* and *Stores*. *Plant and Machinery* is dealt with under that heading.

## EXTENSION OF SERVICE

A number of officers were extended in service beyond the normal date of superannuation, to meet shortages of experienced officers. Leave due that would normally be granted pending retirement automatically constitutes extension of service if granted after the normal date of superannuation ( age 55 years ).

A considerable number of officers were re-employed also. See *Re-employment* and Table G.

## FAIR-DRAWING

This term is used in the Survey of India to mean the drawing necessary to produce a "fair original" (or "fair sheet") from which reproduction by photographic processes can be carried out, either by reduction or by direct reproduction. Though the plane-table sheets ( P.T. Sections ) constitute the original field record—or air survey sections, or compilations as the case may be—they are seldom suitable for direct photographic reproduction and the fair originals too are very jealously guarded for in case of loss or damage the whole fair-drawing process has to be done over again. Fair originals are very carefully drawn in accordance with Departmental rules and are often used again and again for new editions of maps, being corrected as necessary from later field surveys.

2. Fair-drawing was normally carried out at  $1\frac{1}{2}$  times the publication scale so as to fine down drawing and minimize shakiness and errors.

There had usually to be at least two fair originals, one being the contour sheet for publication in brown the other the "combined original" for black, blue, red and any other colours in which *lines* would be printed ; it was our usual practice to separate these colours out for printing by taking a sufficient number of photographic negatives from the combined original so that there would be one negative per colour, other colours being "duffed" out by the negative retouchers. See *Powder Process*.

This system ensured good registration of colours. The system was also excellent when a limited number of colours was to be used and it was the fact that so many maps had been drawn on this system that led us to adopt temporarily a "black and brown only" policy, see *Map Policy*. On the other hand, separate originals for each colour was quicker and avoided the duffing bottleneck.

Experiments had been made with drawing on enamel but without much success ; we could not discover an enamel that would not peel or turn yellow with time ( the latter fatal to the map on account of photography ), presumably for climatic reasons ; "non-distorting" paper ( metal foil sandwiched between sheets—anodised aluminium ) had also been tried but it too had disadvantages not least of which was the difficulty and expense of obtaining it.

3. During the war, "standard" practice had to be varied a good deal. In almost all cases, drawing was at scale of publication, instead of  $1\frac{1}{2}$  times ( as usual ) to save paper, storage space, table space, ink and time ; all very valuable commodities under war conditions. It was inevitable that war maps would not have so good an appearance as those drawn in peace, and would not be so legible.

In peace, grids were usually drawn on the combined original ; their registration hence was more or less perfect except in relation to contours. In the war, grids had to be drawn separately in most cases not only because of the drawing time factor ( two originals

enable twice the number of draftsmen to be employed at one time ) but also because of the duffing bottleneck factor coupled with the introduction of grid colour schemes, see *Grids*. Registration, therefore, became poor ; this too was inevitable. Master grid "masks" were used in some cases.

Whenever there was time, however, combined originals were most satisfactory because they saved paper and did enable emergency printing to be made very quickly in black and brown only.

Each case was dealt with on its merits according to the time factor, the head of drawing work, the head of work in the duffing bottleneck and so on. There was no "standard" war procedure.

4. Both field and fair originals of Burma maps had been transferred to that country following separation from India in 1937 ; the fair sheets were sent to India for publication when required and returned to Burma with the published maps.

The Survey of India fair sheets of maps of 'Irāq and western Irān prepared by the Department were transferred to the War Office, London, shortly before the war with a change in responsibilities as between London and India.

Otherwise, fair sheets of Irān and Afghānistān and of course India were in our possession. See *Map Publication*.

5. The timely action of Lt.-Colonel H. W. Wright ( see *Burma* ) saved for us the fair originals of Burma ; the fairs for 'Irāq and western Irān were duplicated in London and sent out to us.

In the early stages of the war, there was therefore no very great call for mass fair-drawing, the call being mainly for correction to date of the fair sheets we held ; in some cases information for correction existed, in others ( as in Burma ) only air or other surveys could produce it. Just before the war it had been decided that "extra-departmental" corrections would not be accepted without verification on the ground ; this decision had to be reversed on the ground that any up to date information ( of reasonable authenticity ) was better than none.

6. The first mass fair-drawing task was to duplicate the 1/100,000 series of Indo-China ; this task was fairly typical of others of that ( duplication ) type undertaken through the war and involved the copying of several hundred maps, the application of our ( Lambert ) grid and changing from Paris to Greenwich longitude, and from grades to degrees.

In some sheets, it was fairly easy to separate out colours photographically, using colour filters ; in others, it was quite impossible to do so, indeed the sheets were so badly printed and so confused that photography was of little use and there was no means of duplicating the sheet except by tracing it by hand for the publication office. In some cases, portions of a sheet were done photographically portions traced and the whole amalgamated photographically and sometimes yet again redrawn.



This task took about 2 years to complete, other works supervening, but was ready when actually required.

Other similar tasks were the duplication of maps of Siam (Thailand) and certain Netherlands East Indies and Malayan maps.

7. The drawing of a completely new India/Burma series, the 1/500,000 Hind series 5001 (see *Hind Maps*) was a heavy original drawing job; the gridding of many hitherto ungridded maps of India (see *Grids*) was another. Renovation from time to time of our own International Series to meet with changes in military map policy also gave the Department a considerable amount of drawing to do though more for surprinting information or colour layer heighting or changing odd details here and there than in mass fair-drawing.

There were, of course, many hundreds of smaller jobs all involving fair-drawing.

8. As soon as mass drawing entered our war picture it was evident that there must be concentration rather than dispersal of drawing facilities and for this reason the Eastern Circle was moved *en bloc* to Dehra Dūn, joined soon after by most of the South India Party; standardization and control of drawing work then became much easier for practically all drawing power was thereafter in Dehra Dūn or, the one big exception, Calcutta. The latter, however, was under the control of the Director, Map Publication—in Dehra Dūn for the most urgent portion of the war—and hence the directors concerned and also the military Director of Survey (India), could easily get together in conferences to iron out difficulties and frame plans and programmes. See *Eastern Circle, Map Publication Circle*.

9. Draftsmen have been discussed under *Drawing and Draftsmen*. The major problem was not so much the training of draftsmen as the training of officers to examine the work of the draftsmen; it is not difficult to teach a man to draw but it is very difficult to teach him to draw with intelligence, that is to apply the rules and regulations that result in maps of standard symbols and reasonably standard neatness and legibility.

Courses were run for young supervising officers but no course can replace experience.

10. Samples of certain maps are appended, see page vi, *List of Maps*.

## FARMS

Farming out of map publication was possible only to a comparatively small extent, see *Madras, Map Publication*.

The *Mathematical Instrument Office*, however, did considerable farming to the trade.

## FIELD SEASON

This term is used in the Survey of India to mean the active outdoor working season, as opposed to the "Recess Season", the time when office work is done. Usually the field season was the cold weather, the recess season the hot; in some parts of India, however, as in the high Himālayas or in parts of Baluchistān, it is too cold to work outdoors in the winter—in such cases the seasons may be reversed.

## FIELD SERVICE MANUAL

A Field Service Manual for survey units was issued in 1916, based on the survey organization of the 1914-18 war. This contained the equivalent of war establishments (units then were civil units members being granted "relative military rank" and permitted to wear uniform) as well as information about terms of service while on duty with the army.

This Manual was never republished and was eventually superseded, when it was decided to militarize survey personnel working with the army, by *War Establishments and Terms of Service* under which headings relevant information will be found. The *Survey Service Pocket Book* was also prepared as a brief compendium of information on military as well as technical survey matters, for the use of officers and others in the military survey units.

## FINANCE

The Survey of India remained on good terms with the Finance Department of the Government of India throughout the war; projects backed by the Department of Education, Health and Lands and later the Department of Agriculture were readily sanctioned when they had to do with the war and eventually with the post-war expansion of the Department, though anything to do with post-war expenditure naturally received very much closer consideration.

In the matter of appointments for war purposes, the Finance Department readily accepted our views as to their necessity. In matters of pay increases they were more difficult to convince; in the end, however, the Survey of India succeeded in obtaining revised pay and allowance rates that, while less than we considered desirable to retain men on whom we had spent much money in training, were nevertheless sufficiently acceptable to retain the majority of our experienced men.

2. The Surveyor General possessed fairly wide powers in respect of temporary appointments and budget expenditure generally and these were used to further the war effort to the utmost. See *Military Organization*. Expenditure on capital items such as plant and machinery was mainly financed by the sale of maps to the army. On the latter point there was some controversy and much correspondence, see *Map Sales*.

**FLAT RATE MAP PRICES**

After the first year of the war, maps printed specially for the armed forces were charged for at a flat rate irrespective of size, number of colours, where sent, etc. See *Map Sales*.

**FOR OFFICIAL USE ONLY (F.O.U.O.)**

Certain maps and documents were so classified when intended to restrict their distribution and circulation. The change of classification in U.K. to "Not to be Published" (N.T.B.P. was not accepted by India which continued to use "F.O.U.O." When the final change to "Restricted" was introduced and followed by the Allied Forces, India conformed.

In 1940, a new category, "F.O.U.O.—B" was added to the regular F.O.U.O. maps to cover a much extended area of military interest. Restrictions were not quite so rigid in this new area, for it covered many places of civil as well as military interest not only in respect of normal civil administration but also in respect of war factories, etc.; it was, however, essential to exercise considerable care in making maps of such areas available to the general public in war time.

When the term "Restricted" was introduced, F.O.U.O. and F.O.U.O.—B were amalgamated under it. See also Chapter VI, 82 and *Security*.

**FRONTIER CIRCLE**

It is explained under the heading *Military Organization* that the Frontier Circle of the Survey of India was a semi-military circle paid for in part by the army and charged with the duty of raising two Field Survey Headquarters, two Companies and a Survey Depot in the event of war. These were intended primarily for duty on the N.W. Frontier of India and their mobilization stores were held in Risālpur (Survey of India supply) and Rāwalpindi Arsenal (Ordnance supply).

2. The Frontier Circle was formed in 1925 with headquarters at Simla where its drawing office (No. 6) was also situated. See *Drawing Offices* and *Army Section* (6 D.O.). It consisted of three permanent field units, "A" Company, "E" Company and No. 18 (Air Survey) Party and from time to time formed and controlled other units for special works like irrigation and settlement projects in the Punjab and Sind.

In 1939, it had only one special unit, the Lahore Detachment, engaged on a high precision large scale survey of Lahore city. This unit continued to function until the work was completed in the field in 1941 but was transferred to the control of the Eastern Circle in 1940 when the Frontier Circle became heavily involved in the formation of military survey units and other war work.

The permanent units of the circle were engaged on various works in the Frontier area and ( air survey ) Tribal Areas ; some mention is made under the headings "*E*" *Company* and *Air Survey Party*.

3. A considerable amount of military survey training had been done in the Frontier Circle between 1925 and 1939, a comprehensive exercise in co-operation with the Survey Section R.A. having been carried out in 1938 ; another such exercise was carried out in 1939 together with a month's unit training and early in 1940 courses in triangulation for military purposes were run. See *Training*.

As war work increased, routine work in the units of the circle was shelved and by the end of 1941 it was engaged almost wholly in survey and mapping for Northern Command, training and formation of military survey units. There was also considerable work in connection with *Terms of Service*, *War Establishments* and *War Equipment Tables*.

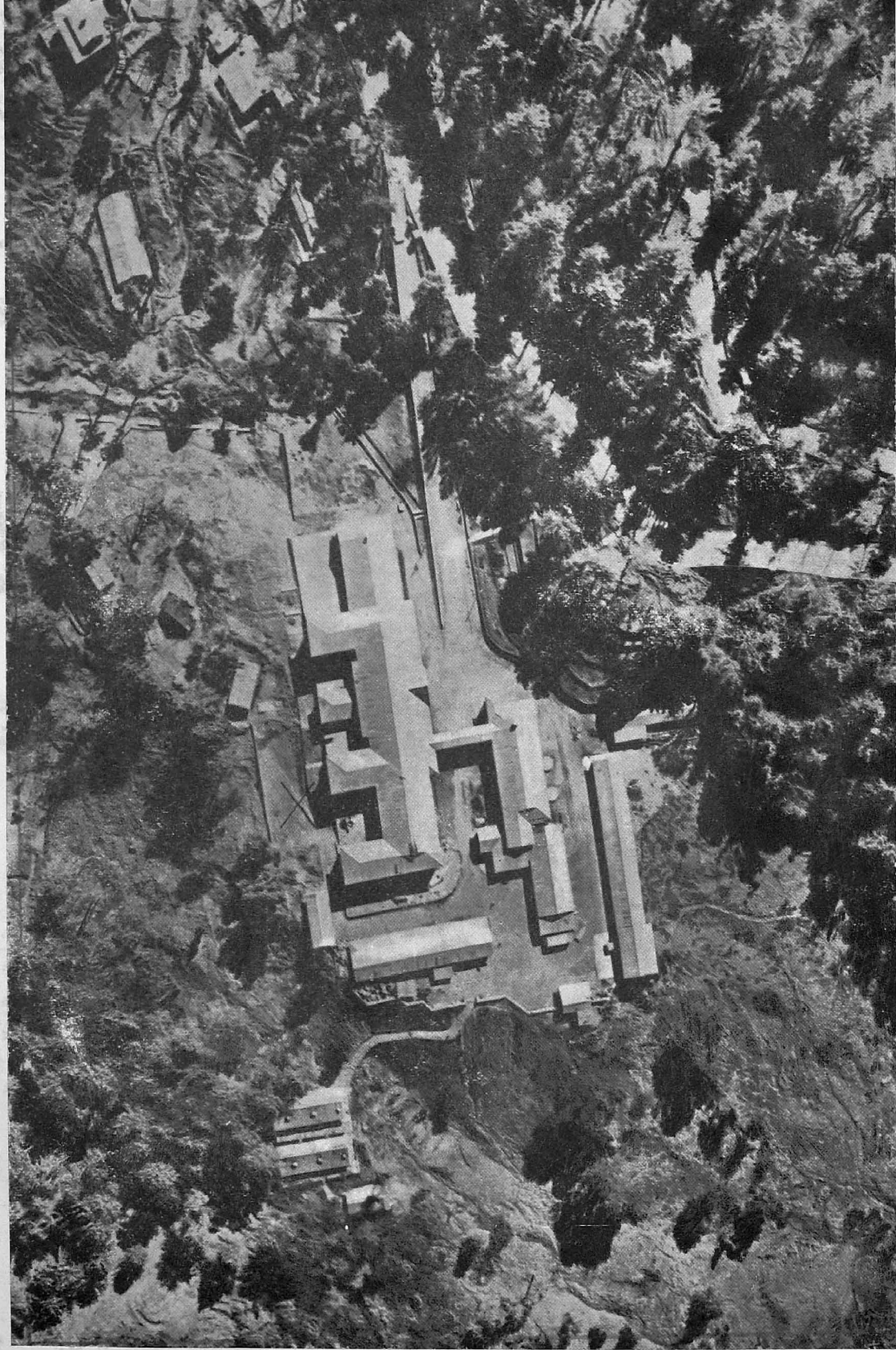
4. During the winter of 1939-40 the Director, Frontier Circle established a temporary headquarters at Lahore, centrally placed for military training in the Risālpur area, certain mapping in progress for Western District in the Sind area, visits to the Surveyor General by then established in Delhi and visits to his permanent offices in Simla. In the summer of 1940 he returned to Simla along with Army Headquarters ; from then on, circle headquarters was at Delhi so far as military work was concerned until taken over by the new *Military Circle* when the Frontier Circle headquarters from both Delhi and Simla amalgamated at Murree. See Chapter V, 61.

The Frontier Circle office ( later the Military Circle office ) at Delhi was alongside that of the Surveyor General in hutments behind the Temporary Secretariat on the Alipore Road, Old Delhi.

5. In March 1940, the Director Frontier Circle accompanied the D.D.M.I., G.H.Q., India to Cairo to discuss survey and mapping problems at a Mid-east-War Office-India conference there and in the winter of 1940-41 was in charge of a similar conference between Malaya, India and Mid-east in Delhi. From these conferences the commitments and policies of the Survey of India developed in respect of military units and mapping. Until the formation of the Geographical Section, General Staff, in 1942 the Director Frontier ( or later Military ) Circle and the Surveyor General of India had between them to deal with all military matters and to attend all conferences at which a survey representative was required.

The D.F.C. was appointed *ex officio* Director of Survey ( India ) in June 1940, passing to the Director, Military Circle on formation and the latter officially became military Director of Survey when the G.S.G.S. was formed in 1942.

6. By 1941 it was clear that the Frontier Circle had become too unwieldy and must be broken up into more than one directorate. As an experiment, the Frontier Circle was left in charge of all military duties, except training, and civil duties ( now fairly small ) in its



AERIAL VIEW OF FRONTIER CIRCLE OFFICES AT MURREE.

normal area ; a separate circle called the Training Circle was formed to deal with all training matters.

This soon proved to be unworkable due to overlapping territorially and to the steady move of interest from west to east. It did however provide a sort of cockshy and transition period during which the D.F.C. was relieved of many problems that had previously harassed him and it did provide a breathing space to think out something better.

The upshot was the formation of the *Military Circle* with headquarters in the Frontier Circle office in Delhi, followed by the creation of the *Geographical Section, General Staff*, the dissolution of the Training Circle and the move of the Frontier Circle headquarters from Simla/Delhi to Murree, the Simla offices being vacated in favour of others seeking accommodation in that congested place. It was fortunate that the new Survey of India offices had been built in Murree, making the accommodation of the F.C. headquarters easy.

7. For the remainder of the war, all military matters were dealt with through the Military Circle in Delhi, the offices of this circle being next door to those of the Surveyor General and 4 or 5 miles from the eventual offices of the Director of Survey ( India ) and the Geographical Section, General Staff.

The Frontier Circle continued to be responsible for all field military training, air survey training and a lesser amount of training in drawing and map publication work, as well as for meeting all demands for surveys and maps from Northern Command/N.W. Army, and such civil work as was undertaken within its area which comprised, roughly, all N.W. India west of a line drawn between Ambāla and Karāchi.

8. For some time No. 6 Drawing Office of the Frontier Circle remained in Simla and then transferred to Dehra Dūn, see *Drawing Offices*. The Frontier Circle did without a D.O., however, utilizing the combined "A" and "E" Parties as such, see "*E*" *Company*. The *Air Survey Party* continued to function in its normal role, though much expanded and its reproduction section, for a time called No. 19 ( Map Reproduction ) Party and for most of the war under the direct control of the D.F.C., dealt with all map publication work in the circle.

Special training units were formed by the Frontier Circle with headquarters at Abbottābād in 1941-42 and in these most of the field training was carried out. See *Training Parties*. Certain units were also used for advanced instrumental training see *Hazāra Detachment* and *Kulu Detachment*.

9. Towards the end of the war reconstruction projects mainly in connection with irrigation and flood control began to come to the fore. These are mentioned in *Projects*.

At this time the Frontier Circle training units were gradually altered from military training organizations to civil training ; it was



necessary to teach men trained along the somewhat narrow lines required for military survey in the wider lines required for civil works and also in the specialized lines required for the methods developed to deal with individual projects not only in the Frontier Circle area but all over India. The Frontier Circle remained the training circle for such works irrespective of which circle was ultimately to carry them out.

In this connection, there was some controversy—centralized versus decentralized training. Perhaps centralized training in fundamentals and specialized methods is sound; decentralized training to meet local conditions should follow. But expense may preclude this desirable state of affairs in a big country.

10. In the reorganization sanctioned by the Government of India in 1946, the Frontier Circle was again constituted as a normal circle with a drawing office, plus, however, training units.

The reason for utilizing the Frontier Circle area for training is its all-season climate, simple topography for beginners rising to extremely difficult mountain areas; it lacks only facility for training in jungle survey methods. This is discussed further under the heading *Training*.

## GAZETTED OFFICERS

The Civil Services in India consist of gazetted and non-gazetted services. Appointments, promotions and retirements in the former service are published in the Gazette of India; those of the latter service are not. In the Survey of India, the Class I and Class II Services are gazetted, as well as certain other special posts, see the following heading, *General Central Service*.

The gazetted services correspond to King's or Indian Commissioned Officers in the Army; the Non-gazetted, in general, correspond to Viceroy's Commissioned Officers in the supervisory ranks and to V.C.O's. or Other Ranks, depending on seniority, in the non-supervisory such as the Lower Subordinate Service. Further details will be found under the service concerned and in Tables A and B.

## GENERAL CENTRAL SERVICE

Officers of the Survey of India who were trained in field and drawing duties, that is who were trained as *survey* officers, were in the Class I or Class II Service of the Survey of India; many of these officers also became specialists in scientific subjects or in map publication work. Specialist officers however, who had been trained as such and not as survey officers, were usually accommodated in the General Central Service, Class I or Class II according to their skill and responsibility.

The General Central Service, Class I, was entirely a gazetted service; the G.C.S. Class II was partly gazetted, partly non-gazetted.







2. Commissions were granted to G.C.S. officers on the same terms and conditions as Survey of India Class I and Class II officers. See *Terms of Service* and Tables A and B.

## GEODESY

Little geodetic work as such was undertaken during the war. Mention of scientific work is made under appropriate headings such as *Levelling*, *Triangulation*, *Gravity*.

This work is of course normally the function of the Geodetic Branch but for the greater part of the war that branch was very heavily occupied with drawing, publication and other work and it became necessary to create an additional directorate, the War Research Institute, to deal with computations and scientific work. See *Geodetic Branch*, *War Research Institute*.

## GEODETIC BRANCH

Originally called the Great Trigonometrical Survey, this branch of the Survey of India had functioned in Dehra Dūn for about 150 years. In later years its functions became more general and at the outset of the war the Geodetic Branch controlled, besides its scientific units, a topographical party (No. 1) responsible for a portion of northern India surveys, the Cantonments Detachment (later, Party), a large drawing office (No. 2) as well as the Forest Map Office, a small Officers' Training School, a Letter Press printing section and a map publication office, called the Photo-Zinco Office (P.Z.O.); the processes used by this office were the same as used by the Photo-Litho Office of the map publication directorate at Calcutta (P.L.O.), the alternative name being given merely to distinguish one office from the other.

It was in the P.Z.O. that the main expansion of the Geodetic Branch during the war occurred, and in the Cantonments Party.

2. Little scientific work was in progress when the war started and all not directly connected with the war was dropped in its early stages (see *Gravity Levelling*, etc.). Later on, when this work built up heavily, a new directorate, the War Research Institute, was created; the Geodetic Branch itself was forced to concentrate most of its effort in drawing and map publication duties, and large scale work for the army (Cantonment Party) and in administration. The office was situated in a large compound in which war demands necessitated the building of a new press room for the P.Z.O., a new studio and many alterations to the existing P.Z.O. buildings, a permanent camp site for the B.O.R.'s. employed in our publication offices (see *Cadres*) and eventually a set of barracks across the road from the compound; as well as thirteen large buildings to house the survey stores organization (see *Stores*), and numerous lesser projects. The administrative work involved in all this building was very great; furthermore, as the old established office in Dehra Dūn, the Geodetic Branch had to do most of the co-ordination of

administration between the various other survey organizations in that place besides handling the administration of the War Research Institute which could not be administratively separated out owing to shortage of clerical staff and buildings.

So far as possible therefore, the Geodetic Branch was relieved of all computational and scientific work and of all training, the Officers' Training School being reformed in Abbottābād, see *Training Parties*. The Branch however, administered the Punjab Irrigation Party, see *Gurgaon*.

3. The Geodetic Branch had been responsible for most of the exploration surveys and mapping of ex-India areas undertaken by the Department. The personnel of its ( No. 2 ) drawing office were thus experienced in this form of compilation work, of which good use was made during the war, and foreign maps, exploration records, etc., were housed in the Branch. When the G.S.G.S. was formed and a foreign map library created in New Delhi under their control, our foreign maps were transferred to them.

Although the P.Z.O. normally published a number of standard Survey of India maps on all scales, the major part of its publication work was special maps of various sorts such as Cantonment and Forest Maps, maps compiled from exploration work, scientific charts and diagrams and the like.

During the war, the P.Z.O. functioned as a map publication agency on exactly the same lines as the P.L.O. and for a time, before the Hāthibarkala offices got into full production, was our largest publication potential, due to the installation of modern high speed machinery. See *Map Publication*.

4. At the start of the war, the P.Z.O. had one hand feed rotary offset printing machine and two flat-bed presses. In 1945 it had in use one hand feed and eight high speed automatic feed machines, of which four were two-colour machine. See Table H.

## GEOGRAPHICAL MAPS

These are maps of a generalized type, such as found in atlases ; there is no specific definition according to scale, but Survey of India maps on scales smaller than 4 miles to an inch ( "quarter-inch" ) are considered to be "geographical" maps. Some of our quarter-inch maps could be called geographical maps owing to over-generalization ; the series is however supposed to be "topographical".

## GEOGRAPHICAL SECTION, GENERAL STAFF (G.S.G.S.)

This army organization, headed by a Director of Survey, ( Brigadier or Colonel ) existed in Britain before the war but did not exist in India where the Survey of India was to perform a similar function, namely to be prepared for war in respect of surveys and maps and to organize survey and map work during war. It was

for this reason that the Class I Service of the Survey of India contained a preponderance of military officers.

In India, the Survey of India was responsible for all survey matters and for the provision of maps as demanded by the Military Intelligence Branch of the General Staff who were advised by the Director, Frontier Circle of the Survey of India. See *Military Organization*, under which heading the general organization for military work throughout the war is followed.

2. Until 1942, all military work was dealt with by the Frontier Circle or ( 1941 onwards ) the Military Circle of the Survey of India. See *Frontier Circle*, *Military Circle*. As commitments increased, particularly in respect of India's position as a general base for the Far Eastern war, it became clear that a purely military organization must be created in addition to the semi-military Military Circle of the Survey of India and the Department's function as Base Organization. The Geographical Section, General Staff was therefore formed, on lines similar and with duties similar to that of the corresponding organization at the War Office. Major M. O. Collins, R.E., who had had considerable experience in the G.S.G.S. at the War Office and who had recently visited America was sent to India to help in forming the new Indian G.S.G.S. No military post could be found for him immediately but, while the war establishments of the new G.S.G.S. were in the melting pot, he was accommodated in the Survey of India in a temporary post created at twenty-four hours notice.

By the end of 1942, the G.S.G.S. was a going concern, housed in the top floor of the Imperial Records Building in New Delhi, thanks to the good offices of the Department of Education, Health and Lands of the Government of India who were responsible for the Archaeological Museum which the G.S.G.S. occupied from then till the end of the war. The building was about 4 miles from the office of the Surveyor General and the Director, Military Circle in Old Delhi and about one mile from the Imperial Secretariat Building in New Delhi where the General Staff were housed.

3. The G.S.G.S. provided the purely military technical staff of the Director of Survey ( India ) who was its head ; his administrative office continued to be the Military Circle of the Survey of India, of which he was the director, see *Military Organization*, *Military Circle*.

From its formation, there was always one military officer of the Survey of India in the G. S. G. S. and other Survey of India personnel was transferred or loaned to it from time to time, as circumstances required. The majority of its personnel however were non-Survey of India and included a number of B.O.R. draughtsmen. The Army Section, No. 6 Drawing Office was transferred to its control and the foreign map library of the Survey of India formed the nucleus of its map library, transferred in 1942. See *Army Section*, *Libraries*, *Green Demands*, *Conferences*, etc.

## GEOLOGICAL SURVEY OF INDIA

Survey programmes and map policy were always framed to fit in with the requirements of the Geological Survey Department as far as possible ; during the war certain scientific work was also undertaken to assist in the search for mica and other minerals and towards its end a Survey programme was framed to provide topographical maps on fairly large scales of a number of coal and other mineral bearing areas in eastern India.

It was also decided towards the end of the war that while the Survey of India would continue to be responsible for main geophysical frameworks, the Geological Survey would be responsible for their expansion and development to meet local mineral and similar requirements. See also *Afghānistān*, 2.

## GEOPHYSICS

The Geodetic Branch of the Survey of India had maintained a scientific staff to carry out gravity measurements and investigate isostatic anomalies and had also carried out a considerable amount of magnetic work ; during the war these activities, along with geodetic work and tide prediction, were handed over to the newly formed War Research Institute. Mention of them is made under the appropriate headings such as *Gravity*, *Magnetic Work*.

Seismic soundings had not been used in the Department though this aspect of geophysical investigation was under consideration when war broke out ; some work was done in connection with the search for mica by electrical ( resistivity ) methods.

Certain of our instruments that were more suited to localized than to deep-seated investigations were handed over to the Geological Survey.

## GRAVITY

A gravity network had been established covering a considerable part of India and work was in progress in Burma when the war started. Measurements were made by means of pendulums though the acquisition of the more modern torsion balances was under consideration. Details are contained in the Geodetic Reports of the Survey of India, that relating to the recent work in Burma, broken off because of the war, being published in the Report for 1940 ( issued in 1945 ).

No further gravity work was done during the war, though some resistivity work was carried out. Deductions from past work made by Colonel E. A. Glennie, C.I.E., D.S.O., proved of great use in locating water in Bikaner for railway purposes.

2. Immediately after the war, programmes were framed to amplify and improve the existing network, in northern Bihār and eastern U.P. for a start ; it was proposed to use torsion balances for this work and Dr. de Graaff Hunter, C.I.E., F.R.S., then Director,

War Research Institute was investigating means for speeding up the levelling required to be carried out concurrently with the gravity work ; this work was carried on by his successor as President of the Institute, Mr. B. L. Gulatee.

3. It was proposed to record gravity values on the permanent marks of the *A.I.D. Survey*, outlined under that heading.

The acquisition by the Survey of India of a considerable amount of motor transport will greatly speed up gravity work.

## GREAT TRIGONOMETRICAL SURVEY

See Chapter I and *Geodetic Branch*.

## GREEN DEMANDS

After the formation of the *Geographical Section, General Staff* publication and drawing work was demanded of the Survey of India by the Director of Survey ( India ) on what were known as "Red Demands" ; they were so called only because the indent form was printed in red to distinguish such demands from ordinary routine indents for maps.

The fact that both drawing and publication was demanded on a single indent caused difficulty, because the drawing required preparatory to actual publication sometimes ran into many months and also drawing was controlled by the Director, Eastern Circle whereas publication as such was controlled by the Director, Map Publication. Indents printed in green, which were demands for drawing work only, were therefore introduced in the latter part of the war and simplified procedure considerably. Red Demands thereafter were for publication only.

On both Green and Red Demands the Director of Survey was authorized to sign "for" the Surveyor General, in his capacity as Director, Military Circle, Survey of India. This saved time and obviated the necessity for duplicate staff. See also *Map Publication*, 10 and *Map Sales*.

## GRID PAMPHLETS

See *Grids*, 5.

## GRIDS

When a piece of triangulation has been completed in the field it can be computed either in terms of latitude and longitude or in rectangular terms ; the former implies the use of spherical trigonometry, the latter plane trigonometry preceded, however, by the "flattening out" of the triangulated area by means of some map projection. For standardization and simplification of computations, both systems require sets of computation forms and tables

of which the spherical ( latitudes and longitudes ) are somewhat the more complicated.

The Survey of India normally used the spherical system for topographical surveys ; for military surveys in recent years the rectangular system had been introduced, utilizing the Lambert conical orthomorphic projection for the "flattening" process. See para 3.

2. In the 1914-18 war, most maps had been arbitrarily squared so that a co-ordinate system could be used to describe accurately the precise point within a square to which an order or an item of information referred. With the development of artillery survey, however, it became necessary to be able to define a point on a different map sheet, or even if there was no map sheet, *in the same terms* throughout a battle area and on all maps of a battle area on whatever scale ; and also, to be able to relate bearings on one sheet to those on another, so that bearing and distance could be calculated for predicted shooting. These requirements implied the use of an organized system of squares, based on some "flattening" map projection with a specific "origin" from which the distance of any point could be described as so many yards ( or other unit of length ) east and north. This is termed a *grid*\*.

3. The best projection for the grid depends on the shape and size of the country to which it is to be applied ; the transverse mercator projection is good for countries long north and south in comparison to their width ; for India; however, whose responsibilities extended east into Burma and west almost to the Mediterranean, the Lambert conical orthomorphic projection is best, and all its grids were based on this projection ; it had to be divided into several belts to ensure that at no place would the scale error exceed  $1/823$  and each belt had to be subdivided to prevent excessive divergence between grid north and true north.

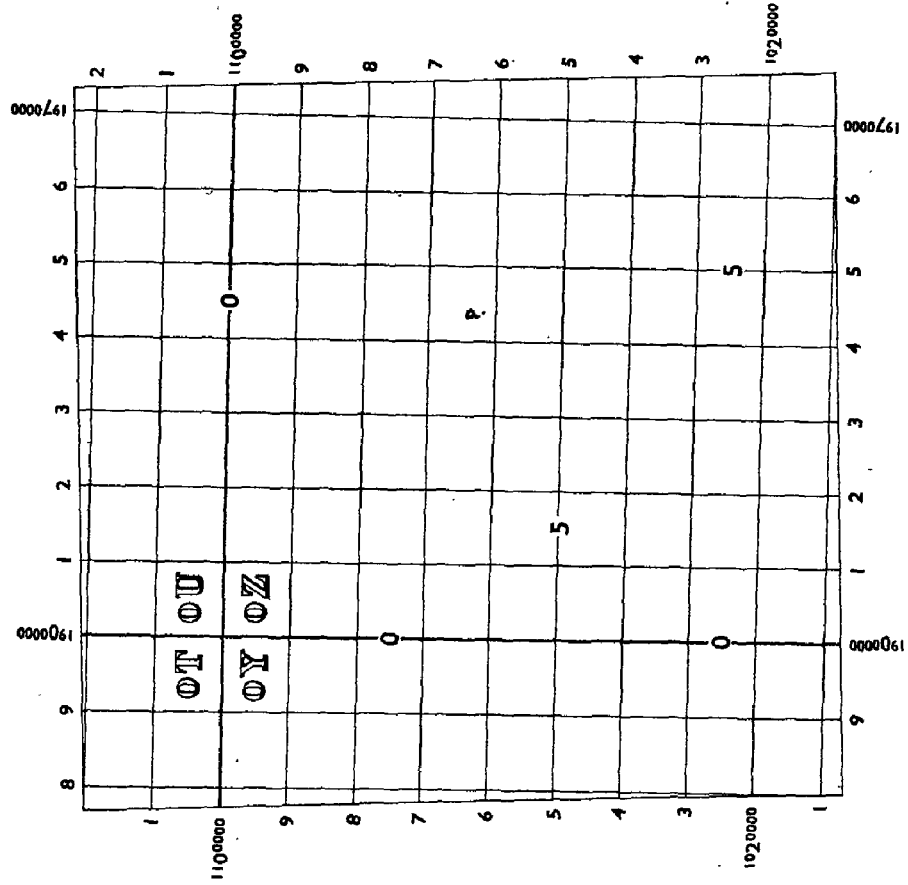
The fact that India's maps were surveyed in spherical terms and plotted on a simple polyconic projection was immaterial to the selection of the grid projection ; the Lambert grid can be applied to them just as well as to maps on its own projection. In military surveys, however, it was convenient to survey in grid terms from the outset, and this was our standard military survey practice. See *Triangulation*.

The referencing system used was that known as the British Modified System, referencing letters and figures being sparsely printed over the face of the map ; towards the end of the war, however, all military maps were referenced on the Canadian System to permit quicker reading of references on a folded map. The two systems are illustrated on Plate IV facing this page.

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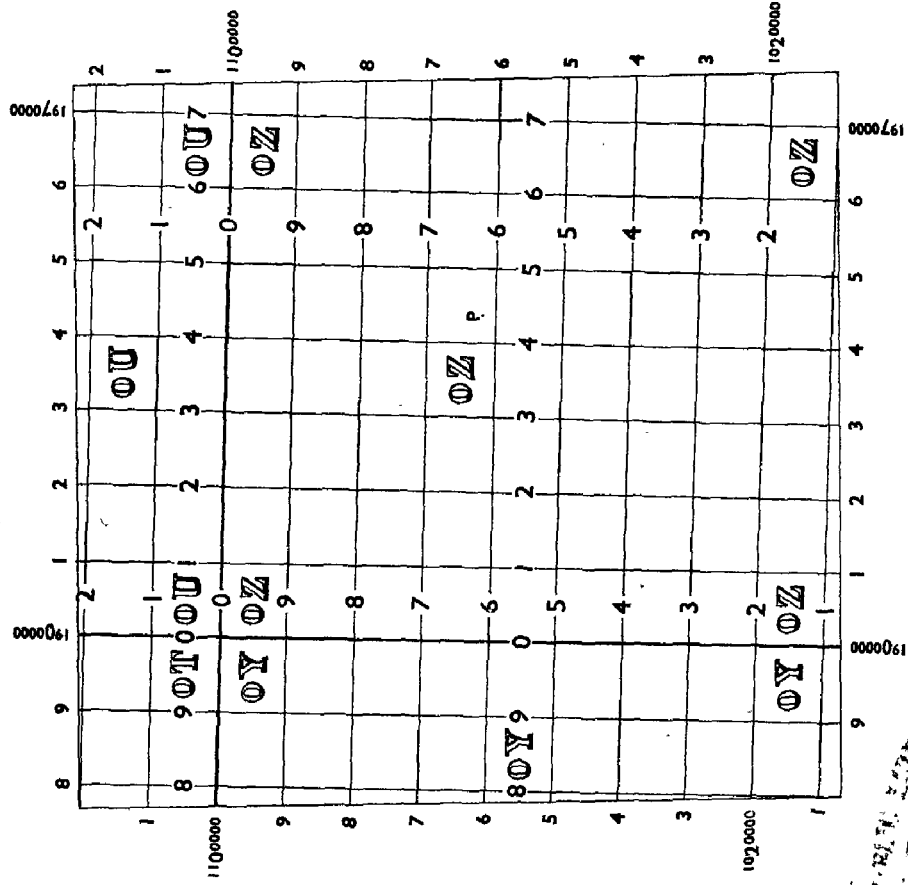
\* The same result can be achieved by the use of a spherical "mesh", that is with lines drawn on the map at one minute or other suitable intervals of latitude and longitude. This system however implies surveys being carried out in spherical terms which are slightly more complicated, see para 1. The Survey of India used a "Minute Mesh" on its maps for some years, but eventually changed to grid. The mesh has the advantage of being world wide ; grids must perforce be in belts, causing troubles at overlaps, and many sets of tables, etc.

Grid on British modified system

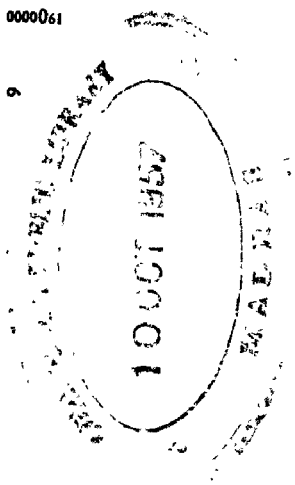


Grid reference of P is OZ 4462

Grid on Canadian system



Grid reference of P is OZ 4462



4. Before the war, grid lines were usually drawn on the "combined fair sheet" ( see *Fair-Drawing* ) which ensured best possible registration ; for the same reason, they were printed in black. It was possible therefore to read off the co-ordinates of any point on the map with great accuracy relative to the triangulation points, also printed in black. Only a small proportion of India's maps were gridded however, and the many hundreds gridded during the war had the grid over-printed ; this led to grid inaccuracy relative to map detail but could not be helped, time being the major factor. Furthermore, a grid colour scheme was introduced during the war so that on many maps the grid appeared in a different colour from the triangulation points, or indeed from any detail on the map.

All military maps of course were gridded, involving a considerable amount of drawing work and typing or hand-printing work, see *Hand-Printing*.

5. Apart from heavy drawing work, grids produced very heavy computational work and letter press printing. Indian grid data, that is the grid co-ordinates of triangulation points, had been published in "Grid Pamphlets" ; many additional pamphlets had to be published, involving the conversion from spherical to grid terms of many thousands of points and also from the terms of one grid or grid belt to those of another and many tables had to be prepared and published for new grids or to assist in conversions from one to another.

The Lambert grid was used on the majority of maps with which the Survey of India had to deal though at the outset maps of Malaya were gridded in two Cassini belts and this was retained for the time being, Lambert later being substituted. See Chapters V, VI, 58, 74.

Full details on this subject will be found in the Survey Service Pocket Book, Part VI and the "Lambert Grid for India". See also Chapter III, 32, 33, 34.

## GURGAON

This district of the Punjab, close to Delhi, is very fertile, given irrigation. When food supplies became short in 1942-43, a "grow more food" campaign was launched by the Government of India ; it was proposed in the case of Gurgaon to combine two purposes, the growing of more food and the settlement of returned soldiers on grants of land. For these purposes, the area proposed for irrigation had to be surveyed.

2. The area involved was about 700 square miles and the requirements were, like previous surveys for similar purposes in the Punjab, the "rectangulation" of the area, levelling to determine the general contour lay-out and hence the lay-out of canals and rough surveys of a topographical nature to indicate the position and shape of excrescences that might interfere with canal alignment.



3. A special party called the Punjab Irrigation Party was formed for this work in 1943 which finished field work in 1945, office work being completed in 1946.

## HAND-PRINTING

For a considerable number of years the Survey of India had been entering names on its fair sheets for publication by means of cast type set up in a hand typing machine ( "Southampton Pattern" ); a number of surveyors and draftsmen had become expert and quick in this process but on the other hand, the art of hand-printing ( hand-lettering ) had been more or less lost. Few of our draftsmen, even the best, were able to produce good hand printed letters except very, very slowly.

2. During the war, many typers were of course on military service ; with our considerable influx of draftsmen, drawing out-turn was much greater than pre-war but typers take a long time to train and so were in short supply compared with drawing power. Names and grid numerals then began to present a problem in quick mapping and it became essential to try to regain the lost hand-lettering art. To some extent this was achieved by concentrating on practice in all stages of training of both surveyors and draftsmen and of course officers, and it was surprising how much lettering improved ; much remained to be done, however, at the end of the war.

3. The simplest form of lettering was taught ; shading and serifs were forbidden. See also *Type*.

## HĀTHIBARKALA

*This heading should be read with Map Publication and Map Publication Circle.*

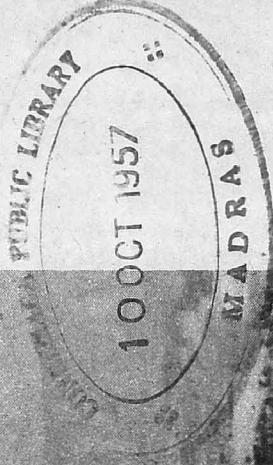
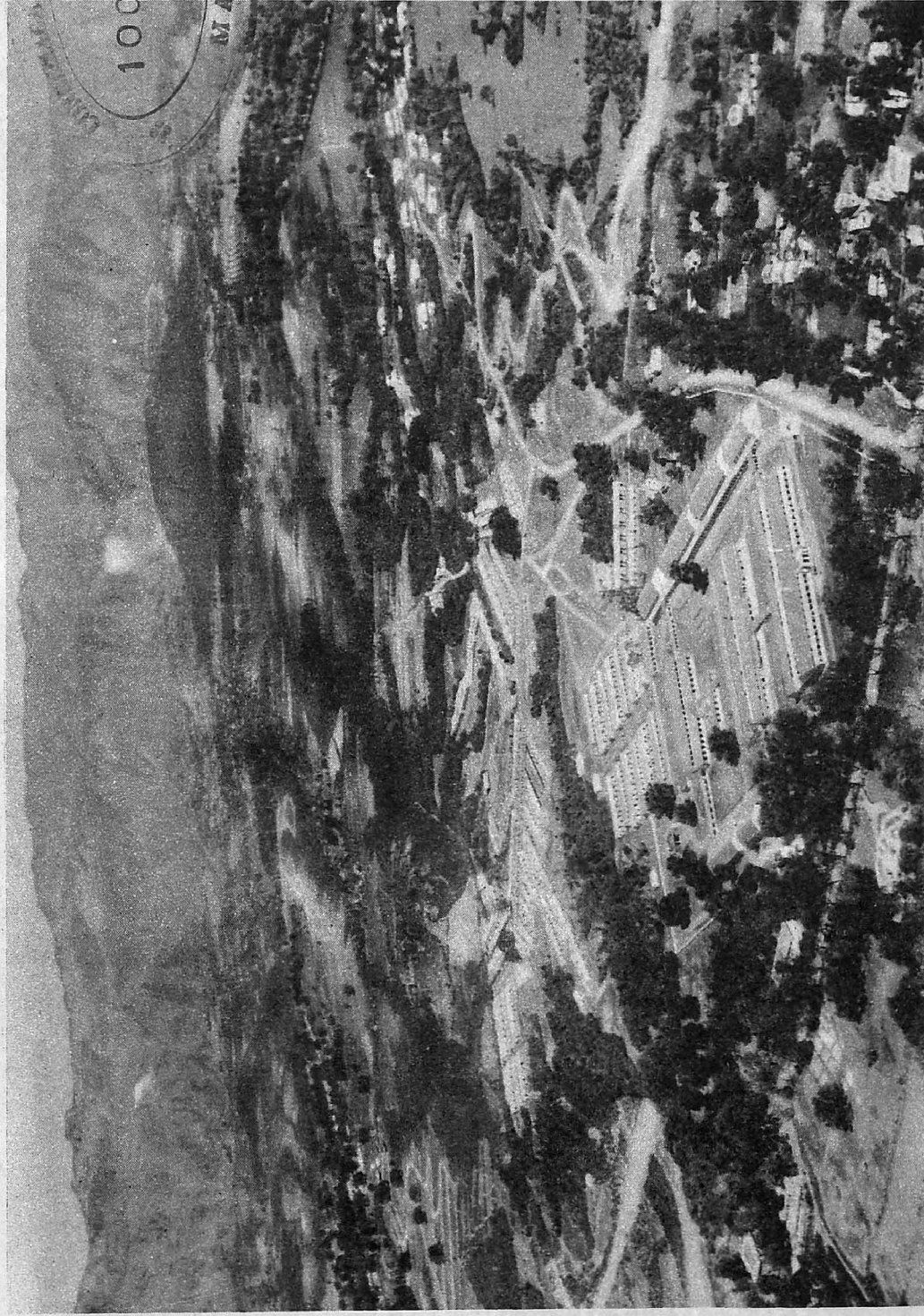
Hāthibarkala is the name of an estate of some 300 acres in Dehra Dūn that gave its name to the new map publication offices of the Survey of India, built upon that estate during the war.

The land had been purchased many years earlier with a view to placing the headquarters offices of the Department there, transferring them from Calcutta ; fortunately the site was still vacant when Japanese proximity to Calcutta made it necessary to build at least a "shadow" map factory farther inland even if not a full working factory, as in the end turned out to be required, even though Calcutta continued to function almost at full strength throughout and in fact ended the war with more map publication power than when it started.

Table J indicates the great increase in map publication that made this necessary.

2. The decision to build new map publication offices was reached early in March 1942 and before the end of that month

Plate V



Reproduced by courtesy of I.A.S. & T. Co. Ltd.,  
Dum Dum.

Reg. No. 3424 HE '50-1020'55.

Aerial view of Hāthibarkala Estate, built 1942-43.

designs had been put in hand at Dehra Dūn, the Director, Map Publication ( Colonel T. M. M. Penney ) making a temporary headquarters there for the purpose and Major D. R. Crone, O.B.E., R.E., being placed on special duty to assist him. Designs were made in consultation with the Central Public Works Department at Delhi as well as the Executive Engineer at Dehra Dūn and the final working plans were made by the C.P.W.D. By July 1942, building was well in hand and by September machinery was beginning to be installed and personnel to be moved from Calcutta. The work had been practically completed by July 1943 and the factory was in partial operation, under the orders of the Assistant D.M.P. ( later Director, Map Publication ), Lt.-Colonel G. W. Gemmell, I.A.

Other locations than Dehra Dūn had been considered but Dehra Dūn was decided on for several reasons besides the fact that a Government owned site earmarked for the Department existed there ; first, that the more closely we could concentrate map publication and drawing work ( while at the same time dispersing sufficiently to prevent wholesale destruction by a long distance bombing raid ) the easier it would be to direct and control it and the more efficient our work would be ; second, that we should locate the new factory at a place where survey personnel already functioned and hence our requirements were well known to the local authorities, engineering and administrative ; third, a reasonably damp climate was desirable for a process, the " powder process ", much used in the Department for certain stages of map publication. See *Powder Process*.

Dehra Dūn fulfilled all these conditions ; the existing large publication office ( P.Z.O. ) of the Geodetic Branch was distant three miles from Hāthibarkala and the Eastern Circle, by then practically wholly engaged on drawing work, was only four miles, and this too was an important consideration. Furthermore, the Director, Map Publication and the great bulk of our map production power would be only 3-4 hours by road from Delhi.

3. The factory was designed on the basis of eight large size ( quad-demy ) modern automatic feed high speed printing machines, with the various ancillaries required to load them, the requisite storage for paper, chemicals, etc., and for the finished maps, on the assumption that the factory might be working 24 hours a day indefinitely. A large drawing office was also included. Transport had therefore to be included in the plant requirements to move materials from the railway and to deliver maps to it. Two ten-ton lorries designed for mobile map printing machinery that were not required by British army units together with ( later on ) some lighter transport solved this problem.

Because there was no available accommodation in Dehra Dūn, residential accommodation for about 600 officers and men and their families had to be provided and water for the domestic use of about 3,000 persons, besides the considerable supply required to work the offices. Electricity in corresponding quantities was required.

These matters were able to be arranged with the Dehra Dūn Municipality and the Government of the United Provinces. They naturally involved a good deal of correspondence and conferring.

Stand-by electric plant of our own was also arranged for so that at least part of the plant could continue to produce maps in the event of sabotage to local power supplies or other emergency.

Water-borne sanitation was not possible owing to lack of sufficient water. Arrangements for sewage disposal had therefore also to be made with the Municipality.

4. The original intention in designing the drawing and duffing and zinc-correcting offices had been to follow the type built in Risālpur and Murree, with a series of wings jutting out from a main building. This was vetoed by the C.P.W.D. architect on account of roof difficulties and in the end a series of long and fairly narrow "blocks" was built, culminating in the machine room which had a floor space of 8,700 square feet and span of 45 feet; the trussed roof spanning this building was of a novel design developed by the Forest Research Institute which enabled short and readily obtainable wood scantlings to be used; other office roofs were of conventional truss design. All roofing was corrugated iron in the factory and on officers' houses; other houses flat roofs.

Some leakage was experienced in the flat roofed quarters but corrected by application of bitumen compounds. Ceilings were omitted in most of the factory; the corrugated iron roofs were high and the heat was therefore not excessive though sometimes quite enough.

5. The offices were arranged in a convenient quadrangle with the working offices placed transversely, a covered way leading from the lowest office, the drawing and headquarter office, through all other working buildings to the machine room at the top. Stores were placed longitudinally along the sides of the quadrangle. A wall had to be provided for security reasons.

Workshops and garages were placed at the top end of the office compound. Residential quarters for inferior servants backed these and quarters for the remainder of the staff extended for about half a mile up the slope to the north of the estate where the officers' quarters were situated, as well as the water reservoir; a service tank was also built at the top of the office quadrangle.

Office construction was of the "semi-permanent" type, residential of the "temporary" type; the latter implies mainly mud brick construction, the former burnt brick in lime mortar. White ants were therefore prevalent and had to be guarded against.

The building and putting into operation of this factory and residential town in so short a time reflects very great credit on the C.P.W. Department and all those of the Survey of India who were concerned, in particular on Lt.-Colonel G. W. Gemmell, I.A., who was in charge of the project from the time building commenced and who did the major part of the installation and organization of the plant and machinery.

6. I have said that the original design was based on an eight-machine factory. Eventually ( 1945 ), ten machines were installed of which five were quad-demy ( two of them two-colour machines ), four were double-demy ( three of them two-colour ) and one was a double-demy hand feed machine for odd jobs. There was also a small high-speed American machine of approximately demy size ; the remainder were British machines, Mann or Crabtree.

Ancillary apparatus in the shape of proving presses, duplicating presses, cameras, plate coating and drying machines and so on was installed to match. The factory was by far the best and most up-to-date of any operated by the Survey of India and there is probably none in Asia that can rival it.

Machinery and plant was supplied through the War Office, priority of supply being given according to the needs of the Eastern War Theatre. It was not possible at that time for the Survey of India to obtain any supplies direct from British manufacturers, all their output being controlled by the Director of Survey at the War Office.

The post-war utilization of all this plant and that of the Geodetic Branch and in Calcutta forms a problem that is discussed under the heading *Information and Art Department*. See also *Plant and Machinery*.

7. There were serious personnel problems, partly because of the dislike of residents of Bengal to moving elsewhere but also because of the relatively low pay of our technical personnel whose skill was perhaps not appreciated by the Government of India, there being practically no lithographic *trade* in India against which to compare it. These points are discussed under other headings, as well as the overall picture of the Map Publication Circle as such, and map publication as such.

A large proportion of the B.O.R. cadre of British technicians and their officers also functioned in Hāthibarkala and their admirable work is outlined under *Map Publication and Cadres*.

8. The movement of and installation of machinery and other plant and stores, the repairs and alterations to buildings hastily put up and occupied before they were really completely ready and the problems of obtaining food shops and other amenities for the two thousand-odd persons living on this newly developed estate created a very great deal of administrative work over and above that for which the Department was normally organized. It was therefore necessary to use an engineer officer, kindly lent by the Engineer-in-Chief, to look after the buildings and transport, to list repairs, alterations, etc., and explain them to the P.W.D. or other officials responsible for carrying them out and to organize transport. It was also necessary to appoint an officer to administer the estate and organize ration supply, etc., with an assistant dealing specially with amenities ; and, for the hundreds of electrical appliances in Hāthibarkala and the Geodetic Branch, to obtain the services of a whole-time electrical engineer.



## HAVILDARS

For mobilized Survey of India personnel the rank of Havildar was reserved for the juniormost Lower Subordinate Service and equivalent personnel. Viceroy's commissioned rank was granted to those of higher seniority. The ranks of naik and below were reserved for the Inferior Service (Khalāsīs). See *Terms of Service* and Table B.

## HAZĀRA SETTLEMENT DETACHMENT

In 1941 the Government of the North-West Frontier Province made urgent demands upon us for two settlement surveys, a small one in the Kurram Valley and a much bigger one in the Hazāra District of the province. In the former, *chandās* (mark-stones) were to be fixed by triangulation or traverse and planted; in the latter, which covered more difficult and rougher country, similar fixing and planting was to be done as well as plotting the *chanda* positions on the *musavis* (village maps) later to be used for the actual settlement work by the Settlement Officer.

The request of the N.W.F.P. Government was strongly backed by the External Affairs Department of the Government of India for political reasons; furthermore, this Government was one of the few provincial governments that made a point of inviting the Survey of India to establish an accurate framework for its settlement surveys, the latter being carried out by relatively untrained men who, to maintain reasonable accuracy, needed a close network of sound control on which to base their work.

We were therefore very loath to refuse the work, even though by this time very busy on war work; a happy solution was eventually reached by which we agreed to utilize the work as advanced training in triangulation and traverse for officers and topographical assistants if the N.W.F.P. Government would agree to accept the likely delay that would result, which they did. We charged only the cost that might have been expected with trained men, additional cost being borne by the Survey of India against training.

2. A strong detachment, called the Hazāra Detachment, was formed in the Frontier Circle in October 1941 and the work, involving about 1000 square miles of steep country and the eventual supply of 3861 plotted *musavis* on scale 40 *karams* to an inch (24 inches to a mile), was completed in July 1944.

Meantime the 200 square miles of the Kurram Valley settlement had been completed by a small detachment of the Eastern Circle between April and December, 1941. Unfortunately a considerable number of *chandās* were removed or disturbed by local inhabitants during the winter of 1941-42 necessitating relaying in the spring of 1942.

3. The Hazāra work was carried out partly by traverse but mainly by triangulation. Main triangulation circuits were taken

off from and closed on existing triangulation of sufficiently good standard, and the many hundreds of *chandras* were fixed by theodolite intersection or resection. There was thus great scope for training in triangulation that, except for its small area coverage, simulated the triangulation required to control topographical maps ; the small area coverage made it the easier to inspect and control the triangulators and to give each person individual instruction both in field work and in computations.

Further to simulate war triangulation methods, a special Lambert Grid was calculated and tables compiled for it that would make the triangulation accurate enough for settlement needs while at the same time permitting the use of standard Lambert computational forms for training purposes. This is probably the first time that a Lambert projection has been used for cadastral surveys, at least in India. See *Projections, Triangulation, Training*.

4. A large number of officers, topographical assistants and temporary computers passed through this detachment and apart from learning technical methods including the use of the plane-table for keeping accurate triangulation charts they learnt to look after themselves in camp in the field, "on their own" ; a very different matter from being looked after in a normal training camp by senior officers and surveyors. They also escaped the boredom that must inevitably result from mere training as such directed to no practical end.

5. This settlement work provided such excellent training that in 1944 we welcomed a request by the Government of the Punjab for a similar survey of a portion of the Kulu District, which was commenced in September 1944 and continued into 1946. See *Kulu*.

It may be repeated that owing to the nature of the ground the majority of work both in Hazāra and Kulu had to be done by triangulation ; this was the essence of their suitability for training purposes.

## HEALTH

Health in the Survey of India was remarkably good throughout the war, though the strain and malnutrition due to high cost of living and shortage of certain grains was beginning to show towards its end.

There were no epidemics and few deaths from disease either in the Department or in the military survey units. See *Leave*, responsible to a considerable extent for this happy state of affairs ; and *Casualties*.

2. The shortage of quinine was responsible for an increase in the incidence of malaria in the Department at one time, resulting in some deaths ; timely assistance from the Department of Education, Health and Lands prevented a serious outbreak. Quinine substitutes were mainly used in the military units, but not to any extent in the civil units except under doctor's orders. Civil units

do not normally have doctors attached nor even readily accessible and hence rely upon quinine to keep malaria in check.

## "HIND" MAPS

Except in the very early part of the war, maps published for the army were specially designed to meet army needs ; in many cases they did not follow standard Survey of India practice.

To distinguish these maps from Departmental maps and at the same time to indicate their origin, they were called HIND maps. To provide an easy means of reference to them and at the same time assist in security measures, each HIND series was allotted a number ; in demanding such maps it was therefore unnecessary to quote scale, etc., but only the sheet and series numbers. To ensure that the correct edition was indented for, each map had on it a boxed note "Refer to this map as so and so, such and such edition".

An example is in the pocket at the end of the book. More detail about map design is given under *Map Policy*.

## HISTORY

The early history of the Survey of India is very briefly sketched in Chapter I. Full and most interesting detail will be found in the *Historical Records of the Survey of India* by Colonel R. H. Phillimore, C.I.E., D.S.O.

The history of the 1914-18 war is contained in Volume XX of the *Records of the Survey of India—The War Record*.

2. In October, 1944, we were asked to provide information for the official Indian history of the war, 1939-45. Copies of the Survey of India War Activities Report and Civil Activities reports were supplied. See *Reports and Returns*.

## HONOURS

A complete list of honours conferred during the war on members of the Survey of India is given in Table F.

These include 2 Knighthoods, 4 C.I.E's., 1 C.B.E., 4 O.B.E's., 9 M.B.E's., 1 Rai Bahadur, 1 Khan Bahadur, 3 Rai Sahibs, 2 Khan Sahibs ; in addition a considerable number of officers and other ranks, detailed in Table F, were mentioned in military despatches and a number were awarded Certificates of Honour or Commendation Certificates by the Surveyor General.

## HUNTER SHORT BASE

This instrument, designed by Dr. J. de Graaff Hunter, C.I.E., F.R.S., is a very important piece of equipment carried by all Indian Field Survey units and also much used by the Survey of India in initiating and checking surveys of all kinds. It consists of a tape about 90 yards long which is suspended in catenary, with or without intermediate supports, the correct tension being maintained by a



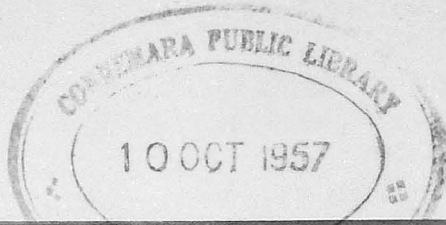
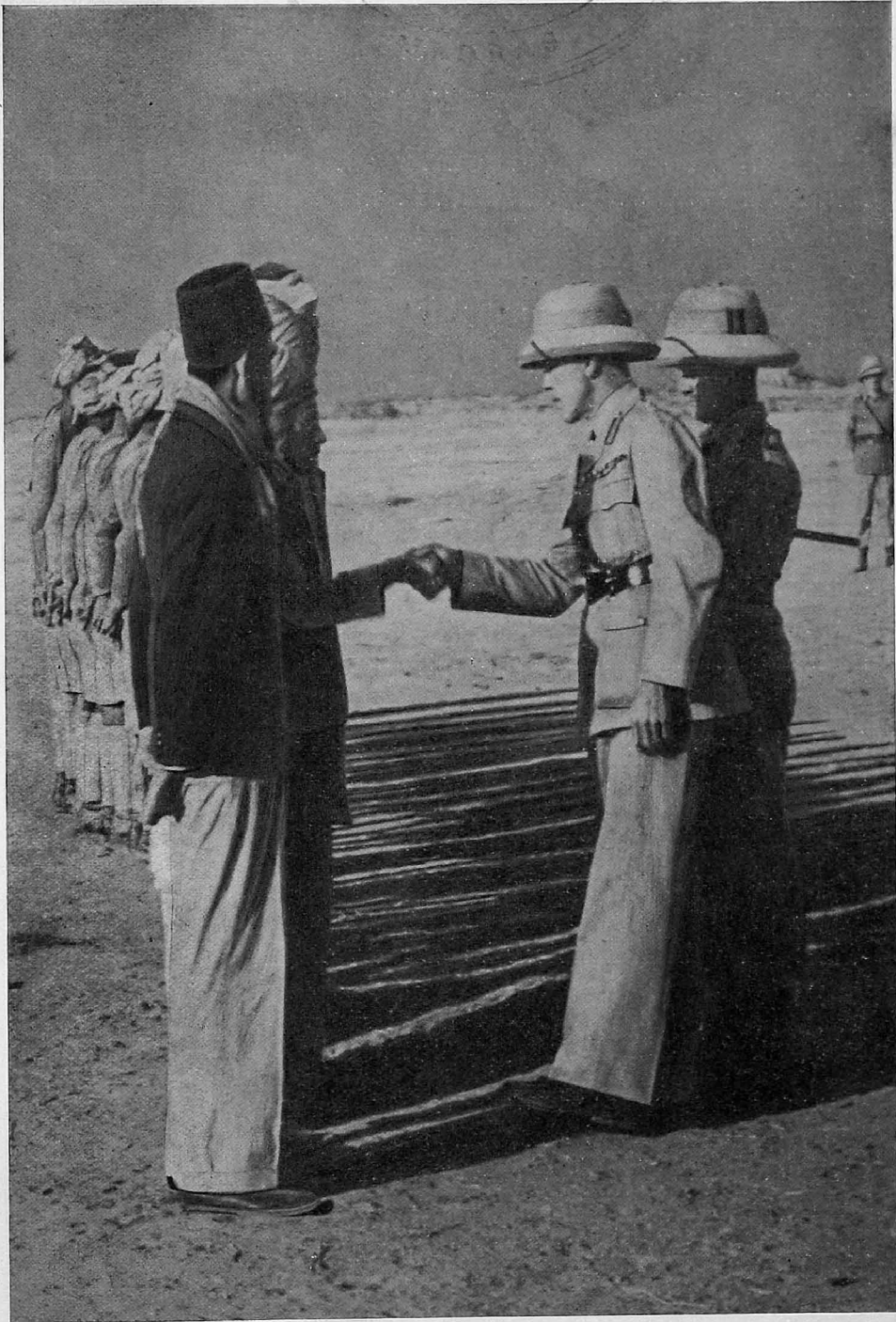


PLATE VIII.



COLONEL E. O. WHEELER, M.C., DIRECTOR, FRONTIER CIRCLE PRESENTING  
MEDALS TO PERSONNEL OF NO. 18 PARTY, MARDAN, N. W. F. P.,  
DECEMBER 1939.

Photo Col. G. F. Heaney.

lever arm and weight on one of the end tripod supports ; calibration data are supplied with each base. Suitable targets are supplied to which to observe with the theodolite.

The base may be set up extremely quickly by men drilled in its use and provided suitable precautions are taken in selecting its location and that of the stations used in its trigonometrical extension, and in measuring the small apex angle of the first extension, very accurate triangulation may be extended from it.

It is described in detail in the Survey of India Departmental Paper 10 and also in the Handbook of Topography, Chapter VIII.\*

2. This base may also be used for accurate traverses by subtense methods, the base providing the subtense "bar". For most accurate results, invar tapes are required.

To meet the needs of certain post-war irrigation surveys Dr. Hunter designed a longer base, with supports high enough to clear crops such as sugar cane and with a platform on which the theodolite could be centred over it at either or both ends. See *Traverse*.

## "HYDEL" SURVEYS

A number of surveys were undertaken for the development of hydro-electric power. These are dealt with under the heading *Projects* or special headings like *Kosi*, *Tista*.

## "IMPRESSION"

In printing parlance, this term is used to mean one printed impression from the inked-up zinc, stone, type or whatever the medium is. In a single-colour machine, it is synonymous with "pull". In a multi-colour machine one pull may result in two or more impressions.

## INDIAN AIR SURVEY AND TRANSPORT, LTD.

This firm, with headquarters at Dum Dum, Bengal, had been established for a considerable number of years, carrying out air surveys, air photography on contract and charter aircraft flights ; it possessed several light aircraft, mostly arranged for vertical photography and several air cameras and maintained a small ground survey section besides its air survey and photo-processing sections ; its pilots were specially trained in survey photography and its facilities enabled processing sections to "take the field" so that in large jobs processing of photos could be done on the spot.

It also possessed an ingenious plotting machine designed and built by the firm's managing director, Mr. R. C. Kemp.

2. Though the bulk of photography for the Survey of India had been done by the R.A.F., particularly on the N.W. Frontier

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\* This Chapter is being amalgamated with Handbook of Topography, Chapter VII—Reconnaissance and Special Surveys.

where there was prohibition on civil flying, I.A.S.T., had also done a lot of photography for us, and some survey work. The company had a considerable library of photographs of many parts of India some of which were its own property, some the property of its clients among them the Burma Oil Company.

The company had also done a large amount of large scale cadastral surveys in flat country, notably for the Government of Bengal.

3. During 1942 unavailability of service aircraft for survey purposes in India and also for miscellaneous photography such as photos to test camouflage became serious ; many small surveys were required of airfields and the like and two large ones, the Sundarbans and some areas on the extreme west of Baluchistān, were in view to satisfy military requests ; at the same time, the R.A.F., were setting up a central photo library in New Delhi and wished to accumulate all available photographs of India and Burma. Air survey potential too was short.

A charter proposition by I.A.S.T., was therefore welcomed by us as well as the Army and R.A.F. and its value was quickly recognized by the Government of India ; two or three conferences resulted in quick action and a charter went into force in October 1942.

4. Under this charter, which continued throughout the remainder of the war and was operated by the Surveyor General on behalf of the Government of India, I.A.S.T., placed its survey and photo-processing resources at our disposal, as well as two photographic aircraft ( Leopard Moths ) and one reconnaissance aircraft ( Hornet Moth ). These were later varied in style and numbers. Messrs. I.A.S.T., made available to the R.A.F., library its whole library of photo negatives, the company having obtained the permission of its private clients to do so in furtherance of the war effort. It was agreed that if we had no immediate use for any aircraft or personnel, the company would be free to use them for other purposes.

It was also agreed by the R.A.F., and Director of Civil Aviation that airfields and their facilities might be used free by I.A.S.T., and the R.A.F., agreed to supply photographic materials, difficult to obtain from civil sources.

After working out the values of the various services tendered by both sides, the annual fee for the charter was decided and agreed. There was no cross-accounting between the various government services involved ; the aircraft and other facilities were used to the best advantage of all concerned, the Surveyor General consulting those concerned as necessary.

5. In all, 54,962 photographs were taken by I.A.S.T. under this charter, up to July 1946. Survey work was allotted to the company in accordance with its potential, including that of the Kemp plotting machine ; some of its personnel were borrowed by the Survey of India to work with the Department.

Major survey projects photographed by I.A.S.T. were the Sundarbans area in 1942-43 and the western Baluchistān-S.E. Irān area about the same time, both for military purposes ; the Bālipāra Frontier Tract for the Political Department of the Government of India ; and a number of irrigation, hydel and flood control projects in several parts of India for post-war development and "grow more food" purposes. See *Projects, Baluchistān, Assam, Sundarbans*.

6. In 1941 I.A.S.T. photographed a considerable area in the Shan States of Burma, covering approaches from the east, for the correction of maps of these approaches by the *Burma Survey Party*.

## INDIA AND ADJACENT COUNTRIES MAP SERIES (I. & A.C.)

The I. & A.C. 1/1,000,000 map series was the original geographical map series of India arising out of the 1905 Committee's recommendations, see *Map Policy*. It was arranged on arbitrary numbering of "squares" of latitude and longitude  $4^{\circ} \times 4^{\circ}$  which was well known to map users in India. Not long before the war, this series was allowed to become obsolescent being replaced by the "International Series" covering  $4^{\circ} \times 6^{\circ}$  with different and more complicated numbering. Our topographical series, one-inch, half-inch and quarter-inch maps, being arranged in accordance with the old I. & A.C.  $4^{\circ} \times 4^{\circ}$  arbitrary numbering were hard to connect with the International. Complete change of numbering had been mooted but the difficulties were so great, involving as they did practically all Survey of India records, triangulation pamphlets, levelling pamphlets, etc., that they were never faced, the situation occurring as it did just as the war started—when the International Series had practically superseded the I. & A.C.

We went through the war therefore with our 1/M maps on one system of numbering, our larger scale maps on another. To Indian map users this presented no problem ; to those coming from elsewhere our numbering must have seemed curious, to say the least.

The sheets of the International Series, however, had not all been completed when the war started and in some areas the old I. & A.C. was the only 1/M map available, in others both were available but the International was the more up-to-date and in some only the International existed, except for a few record copies of the older system. Examples of each system are in the pocket at the end of the book.

## INDIAN ARMY

Officers of the Indian Army had been recruited to the military cadre of the Survey of India roughly in the proportion of one to three officers of the Royal Engineers. See *Cadres*.

With the creation of the Corps of Indian Engineers (later R.I.E.) recruitment policy was somewhat altered and though

Indian Army ( non-Engineer ) officers were still eligible, the preference was for officers with engineering training.

2. There were two European and two Indian officers of the regular Indian Army ( non-engineer officers ) in the Survey of India during the period of the war. These were Colonel L. H. Jackson, Colonel G. W. Gemmell, Major Gambhir Singh and Major R. S. Kalha.

3. Soldier surveyors from many regiments had joined the Survey of India in the years preceding the war ( see *Soldier Surveyors* ) and during the war over two hundred soldiers were trained by the Survey of India, civil recruitment of surveyors having been stopped.

4. All those civilians who were militarized from the Survey of India were granted Emergency Commissions or Viceroy's Commissions or were enlisted, as the case might be, in the Corps of Royal Indian Engineers.

A number of E.C.O's. of the Indian Army, R.I.E., and others, were also trained by the Survey of India for survey or connected duties.

5. The Indian Army Unattached List ( I.U.L. ) was something of a "catch-all" for officers and other ranks not borne on any specific military strength; the British draughtsmen of the Army Section of No. 6 Drawing Office ( Simla ) were borne on this list, as also a number of soldier surveyors. See *Army Section* and *Soldier Surveyors*. It was gradually being abolished about the time war broke out. See also *Reserves*.

## INDO-CHINA

In the later stages of the war Survey of India personnel were employed in Indo-China in certain military survey units. Our main connection with this country, however, was in respect of a quarter-inch map series that had been produced by the French government of that country and was required to be compiled and fair-drawn by us, substituting English for French names, English for French symbols and glossaries, latitudes and longitudes based on Greenwich instead of Paris and on the degree instead of grade system of measurement—and, not least, the application of our grid system.

That our only material from which to reproduce this series was a single set of rather indifferently printed actual maps in many colours—indeed there were one or two gaps in the set—did not make the problem easier.

2. For reasons that will be evident from the foregoing, the production of this series took a long time and exercised the ingenuity of our drawing and map publication experts; we even lacked a skilled French scholar. The majority of the work was done in the Geodetic Branch at Dehra Dūn. See *Fair-Drawing, Map Publication*.

## INFERIOR SERVANTS

The Inferior Service of the Survey of India, now called Class IV Service, contained those persons that were sometimes called "unskilled labour" and for this reason their pay was very low indeed. In fact, many men in this service were highly skilled in their particular tasks even though illiterate or nearly so.

The field staff, khalāsīs, mates, tindals, duffadars and jemadars, were required to know how to pitch and break camp, to chain (*remembering* chained distances because they could not write them down), to set up and direct heliotropes in triangulation work, to hold a levelling or traverse stave correctly and a host of other things; the seniors, duffadars and jemadars were required to be sufficiently literate to keep simple accounts in vernacular or English and sufficiently trustworthy to handle considerable sums of cash.

The office staff, khalāsīs, etc., and jemadars, were required to know how to mix inks for the draftsmen, besides often knowing field work as well and the seniors were required, like the field staff, to be able to keep accounts and to handle money safely. Daftaris were required to know how to do book-binding work, to make up account books and the like.

The reproduction staff knew how to mix printing inks, to grain and coat zinc plates, to work a hand press and so on. This type of personnel was in fact frequently promoted to superior service; the field and office staffs seldom if ever were.

During the war, another "trade" came into being in the inferior service, that of packers whose business it was to count maps and pack and bundle them for issue.

2. On militarization, inferior servants were granted military rank according to their civil status—Sepoy, Lance-naik or Naik, the latter being the highest military rank attainable by this personnel. The next highest military rank, Havildar, was reserved for the juniormost superior service personnel.

This caused some difficulty at times because, particularly in Map Supply Sections, non-Survey of India officers commanding them did not know that the rank of havildar in effect represented a superior service officer of the Department; so far as soldiers directly recruited to the military survey service were concerned it did not matter, but where Survey of India personnel was involved, there was cause for grievance.

This was one of the penalties of fixing military ranks in relation to civil rank; without it however, it would have been extremely hard to obtain volunteers for military service. See *Terms of Service*.

3. In the earlier units formed, the great majority of Indian Other Ranks (excluding havildars) were Survey of India inferior servants. As the war progressed, however, much of our recruiting ground had been covered by the army and it was very difficult to



find men who would volunteer for military service, even if we could get them for service in the Department. I.O.R.s required as field and office staff had therefore to be obtained from military sources. Those required for map reproduction sections, however, continued to be supplied mainly by the Survey of India.

## INFORMATION AND BROADCASTING DEPARTMENT

The Information and Broadcasting (later Arts) Department of the Government of India among its other functions produced a number of magazines and brochures containing high quality illustrations in monochrome or colour with coloured pictorial covers. This Department had difficulty in obtaining what it required from the trade in India and called upon us for help.

At that time (1945) we were fortunate in having in our attached Officers' Cadre two R.E. (E.C.) officers of exceptionally high qualifications in the British lithographic trade, Captains Hodkinson and Rowlands, who had done a very great deal towards organizing our Hāthibarkala map publication offices to the high pitch of efficiency they had by then reached. Though we had very heavy map publication programmes in hand, they had become of a routine nature—being by then fully organized—and we had a large B.O.R. staff some of whom were very expert technicians; with V. E. Day and the imminence of V. J. Day, these men began to become impatient of delay in demobilization to get back to their skilled jobs in U.K. and welcomed work worthy of their skill. Furthermore, we had a very large amount of modern high speed litho-printing machinery and we were somewhat exercised as to what to do with it when the war ended. See *Plant and Machinery* and *Stores Organization*.

2. The I. & B. work meant exercising considerable ingenuity and skill to adapt it to litho processes and if we could teach our men to do it, must result in achieving a very high standard of work in our publication offices; very long runs, in multiple colours, were also required, meaning a fine backlog of work to employ our large quantity of plant indefinitely, thereby preserving it, and the skilled operators necessary to run it, for any other national emergency that might occur in the future; the only alternatives appeared to be wholesale scrapping of plant and dissipation of trained personnel, or placing plant on "care and maintenance", which also would lose us the personnel.

Captains Hodkinson and Rowlands carried out experiments that convinced us, and the I. and B. Department, that we could do their work, of the standard required, much better than the trade and no more expensively, quality for quality. Furthermore, the cost would be paid by one Government Department to another and the integrity of our large publication organization would be preserved against any later emergency. An example of the work faces page 189.

3. There were numerous conferences and much correspondence. One large conference in January 1946 held in New Delhi under the auspices of the Department of Agriculture showed clearly that there were many departments besides the Department of Information and Broadcasting that would be ready to use our facilities. Tentative agreement was also reached with the army in respect of ownership of the plant involved, supplied by the War Office for war purposes at no cost to the Survey of India; the army too was interested in having large map printing potential at their disposal in case of future war.

Unfortunately, negotiations broke down on the score of finance; it would have been necessary to retain the services of Captain Hodgkinson and several other British technicians for 2 or 3 years to get the process fully going and our men trained in its application.

Other work of lower technical quality but also requiring long runs, has however, been found that will employ our large amount of plant at least partially, and preserve a fair number of our best skilled staff.

## INKS

Lithographic and printing inks of different sorts for the various processes and of a large number of colours formed a considerable item of stores supply, practically all of which had to be imported. The total amount of printing inks used during the war was approximately 29 tons in the Survey of India alone. Supply was made to military survey units of approximately a like amount.

2. Black drawing ink normally was of the variety that is supplied in stick form and mixed by rubbing up with water, except in No. 18 ( Air Survey ) Party where ready mixed waterproof ink was widely used. Military units and to some extent civil units other than No. 18 Party used the ready mixed ( bottled ) type during the war.

Coloured "inks" had also usually been mixed from dry water colours, except in No. 18 Party. Bottled inks of various colours were also used much more widely during the war. They are, however, apt to "run" more than water colours on indifferent paper and had therefore to be used with caution. See *Paper*.

## INSTRUMENTS

Before the war, all instruments and nearly all equipment ( tents being a major exception ) used by the Survey of India were obtained through or manufactured by the Mathematical Instrument Office, a part of the Department's headquarter offices in Calcutta. High precision instruments such as theodolites and levels were not manufactured in India though their manufacture was being considered. Compasses and binoculars began to be manufactured early in the war and it was a curious paradox that soon after binoculars were removed from the "Survey of India supply" list and



placed on the "Ordnance supply list", the M.I.O. began to supply binoculars to the Ordnance Department.

This question is discussed in more detail under the headings *Mathematical Instrument Office* and *Stores*. See also Chapter II.

2. The instruments used by the Survey of India and hence by military survey units formed from its resources differed in type from those used by units based on U.K. Ours were designed to meet the special needs of India and Indian survey methods, theirs to meet the needs of their methods. It was not always easy to reconcile discrepancies in this respect and both British and Indian survey personnel had to accustom themselves to working with unfamiliar instruments at times, or to adapt methods to the instruments available. See *Plane-tableing*.

3. Theodolites and levels were our shortage throughout the war, particularly the former. Modern survey technique requires the use of glass arc theodolites for speed and accuracy; these were at a premium in India, the Survey of India possessing a number of Wild (Swiss made) theodolites, many of them very old, but few of the modern British standard glass arc instruments, the "Tavistock". Thanks to the co-operation of the War Office, our deficiency in respect of these instruments was made good. See *Theodolites*.

Other instruments were mostly manufactured in India during the war, including drawing instruments. The *Hunter Short Base*, an Indian innovation, has been mentioned separately. The "M.I.O. stereoscope" was in common use in the Eastern Theatre throughout the war.

## INTERNATIONAL ( 1/M ) SERIES

This 1/1,000,000 geographical map series was in process of superseding the older India and Adjacent Countries Series of the Survey of India when the war started. Its  $4^{\circ} \times 6^{\circ}$  lay-out was followed in all 1/M maps produced during the war, though the map design did not always follow the original design laid down by the International convention that initiated it. There is more detail about this under the headings *India and Adjacent Countries Map Series* and *Map Policy*.

2. When the question of international air charts arose ( see *Aeronautical Charts* ) the Survey of India advocated adherence to the International map lay-out system for these charts, and to the International projection. We had for many years been producing aeronautical maps on this system, approved by the R.A.F. Most of the aeronautical maps of the war were laid out on this system, in India. India was one of the few countries that had really produced considerable numbers of maps on the International system and it was reluctant to see this system, proven by time, being scrapped.

## INVAR

Invar is a metal with very low coefficient of expansion and is consequently used for very exact measurement of length, particularly in areas where there is a great range in temperature. It is much more expensive than steel and less robust and its use is therefore confined to special jobs. Its use in Hunter Short Bases adds considerably to the accuracy of triangulations emanating therefrom.

## IRĀN

During the 1914-18 war the Survey of India had survey parties in various parts of Irān ( Persia ). There were some half-inch maps of these areas, much out-of-date in 1939 ; there was a quarter-inch series covering the whole country, mostly from information of an "exploration" nature and of course our geographical maps on 1/M and 1/2,000,000 (1/2M ) scales covered this country.

Shortly before the war responsibility for areas west of longitude 48° East had been handed over to the War Office.

In 1942 Mid-east assumed responsibility as far east as longitude 54° ( about the middle of Irān ) and in 1943 still further east to 60° thus taking over practically the whole of Irān.

2. Early in the war in Indian force was sent to 'Irāq/Irān and a number of maps of western Irān were called for ; existing fair originals were corrected up to date from any information available before being republished, interim supply being made from such stocks as were stored on our shelves. Copies of our originals sent to the War Office were also obtained from them and corrected so far as their and our information went.

When military survey units went to that area, they gradually took over the publication of maps required by the Force.

3. Up to 1943, when most of the Indian Survey units were withdrawn from the Paiforce area, they had carried out a considerable amount of triangulation and mapping work in western Irān as well as in 'Irāq ; this is mentioned under the heading 'Irāq.

Some ground and air survey was done in eastern Irān on the Baluchistān border by a Survey of India unit in co-operation with a military unit based on India and a triangulation connection was made in 1944 between Paiforce and India. These are mentioned in more detail under *Baluchistān*.

## 'IRĀQ

Until shortly before the war the Survey of India had been publishing maps of 'Irāq on quarter-inch scale and on geographical scales ; much of the information in these maps had been obtained from surveys made by Survey of India units in the 1914-18 war. A survey department had been formed by the 'Irāq Government which was headed by an ex-Survey of India officer, Mr. A. J. Booth

and some Survey of India personnel had been employed in it as instructors.

Responsibility west of 48° East Longitude having been transferred to the War Office just before the war, the Survey of India was in a little difficulty in providing maps for the troops first sent to 'Irāq from India ; this was corrected by transfer of material back from the War Office as time went on and eventually the military survey units sent from India took over practically all responsibility. These were gradually replaced by Mid-east units and by 1943 practically all Indian units had been withdrawn for service in the Eastern Theatre. See *Military Survey Units*.

2. At a conference in Cairo in March, 1940 attended by the Director, Frontier Circle ( Chapter V, 59 ) Survey of India commitments in 'Irāq were decided and a map policy framed that would fit in with Mid-east ; in the end, the Survey of India as such had little to do with map-making in 'Irāq though most of the work up to 1943 was done by military survey units formed almost entirely from Survey of India resources, working for the most part under the order of Mid-east.

The first units formed by the Survey of India, No. 1 Field Survey H.Q. and No. 1 Field Survey Company, went to 'Irāq early in 1941 and were followed by Nos. 2 and 4 H.Q. and Companies besides one extra drawing section, one map supply section and one survey park section ( whose business was to hold reserve instruments and stores ). Each company had a map reproduction section with rotary printing machine and ancillary equipment and by the middle of 1942 a strong survey and map publication organization was functioning that was continually being reinforced by and eventually almost completely replaced by British units from Mid-east, to enable Indian units to move eastwards as the Japanese war developed. See also Chapter VII 100, VIII, 103.

3. During their time in 'Irāq/Irān the Indian Survey Companies surveyed or revised about 120,000 square miles in 'Irāq and over 100,000 in Irān, on quarter-inch and 1/100,000 scales by ground survey methods ( plane-tabling ) ; they mapped about 4,500 square miles from air photographs on the 1/50,000 and 1/25,000 scales.

To enable the above surveys to be carried out, triangulation of an accuracy approximating that of our Indian topographical triangulation supplemented in the flat desert areas by Hunter Short Base traverse was carried out over the whole area of survey.

Work was carried out in areas varying from sea level to 10,000 feet above it, in temperatures varying from 127° to zero degrees Fahrenheit. Out-turns in ground survey reached such high figures as 600 miles per month on quarter-inch work and 100 on 1/100,000 work.

The work carried out by the survey units of Paiforce and Tenth Army, up to the time most Survey of India personnel had been withdrawn, is described in detail in the report by Colonel G. F. Heaney, who was the senior Survey of India officer employed

in 'Irāq, entitled "Report of the Work of Survey Service with British Troops, 'Irāq, Tenth Army and Persia-'Irāq Force".

4. The 'Irāq survey had carried out some first quality triangulation in parts of 'Irāq and established a very accurate base near Baghdād; it had also carried out a considerable amount of topographical triangulation in various parts of the country. In the 1914-18 war, the Survey of India had also carried out a large amount of triangulation in 'Irāq and western Irān; work had not been co-ordinated and to assist in doing so, an Upper Subordinate Officer of the Survey of India of considerable computing ability was sent to Baghdād in 1940, having been briefed from India in the light of Survey of India adjustment methods. This officer's main task was to obtain common points between the geodetic triangulation fixed by the 'Irāq Survey Department and the old Survey of India work to enable the two triangulations to be brought into the same terms.

Officers representing the Survey of India and Mid-east also met in Baghdād at this time to discuss geodetic and triangulation adjustment problems.

Final adjustment of this triangulation was carried out in India and results communicated to 'Irāq. The work carried out by the Survey of India in Irān (Persia) in the 1914-18 war though serving its purpose at the time was found to be so disjointed and of such low quality as to be useless for the much more accurate surveys of 1941-42.

The triangulation connection between Irān and India referred to under *Baluchistān* connected 'Irāq and India geodetically, the western Irān triangulation being in terms of the 'Irāq primary triangulation. The discrepancy\* was not so great as could be expected considering that the two countries based their work on different assumptions for the spheroid; it was not sufficient seriously to embarrass map users on the map scale available, namely quarter-inch. See also *Spheroids, War Research Institute*.

## IRRIGATION SURVEYS

A number of surveys to initiate irrigation projects in connection with "grow more food" and post-war reconstruction were undertaken during the war and immediately after it; some of these were in connection with projects involving hydro-electric power or flood control or both. They are mentioned under *Projects* or the particular project concerned.

In most cases special methods had to be devised to meet requirements with a minimum of personnel and instruments.

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\* If the results of the Irān work are expressed in terms of Clarke 1880 Spheroid in keeping with most of the Mid-east Triangulation and are based on triangulation in 'Irāq origin terms, the co-ordinates of stations close to the meridian of 60° E which was chosen as the dividing line between the area of mapping responsibility of Mid-east and India differ from their values in terms of the published Indian triangulation pamphlets by + 12". 1 in latitude and -4".4 in longitude (in the same Indian Minus trend).

**I.U.L. ( INDIAN UNATTACHED LIST )**

See *Indian Army*.

**KARAM**

The *karam* is a unit of length used in northern India that varies in different places. In the North-West Frontier Province ( Hazāra ) it is  $4\frac{1}{2}$  feet and in the Punjab ( Kulu )  $5\frac{1}{2}$  feet.

**KEY LEAVE**

In the latter part of the war leave out of India was granted to key civil personnel to refresh them before undertaking post-war reconstruction problems. The various types of leave and their problems are discussed under the heading *Leave*.

**KHALĀSĪS**

"Khalāsī" is the juniormost rank in the Inferior Service of the Survey of India ; the term is used broadly to include all field staff of the Inferior Service. See *Inferior Service*.

**KHOJAK**

The Khojak Pass through the Khwaja Amran Range is the main artery between Quetta in Baluchistān and Kandahār in Afghānistān. Up-to-date surveys of this area were required by Western District in 1940 and executed by No. 1 Indian Field Survey Company, see *Baluchistān*.

**KOSI**

The Kosi is a large and very turbulent tributary of the Ganges River that drains the southern slopes of some of the highest Himālayas through Nepāl, indeed one of its branches, the Arun, drains also the north slopes of Mt. Everest and breaks through the Himālayan chain east of that mountain. The eastern part of the province of Bihār was liable to very serious floods and devastation when this river was in flood due to melting snows and the danger extended far down the Ganges into Bengal.

The project to control these floods by the building of a huge dam across the Kosi at its exit from the Nepāl hills, coupled with auxiliary hydel and irrigation schemes, was ( except perhaps for the Tista Project ) the biggest with which the Survey of India was concerned during and immediately after the war ; it was initiated late in the war and a small party, acceptable to the Nepāl authorities, was sent into that country to make the preliminary surveys for the dam on the ground, Messrs. Indian Air Survey and Transport taking a large number of photographs under our charter with them

from which to make more detailed examination of the possible sites and to make more detailed and leisurely surveys. A photographic programme covering several seasons was also planned to cover the plains area into which the Kosi expanded and flooded.

2. From a ground survey point of view, the major problem was to devise methods for carrying out the survey of the plains area ( about 6,000 square miles ) with maximum speed at minimum cost ; maps on the scale 4 inches to a mile were required by the irrigation authorities which must show the general trend of contours as well as reasonably accurate details of major obstructions to the lay-out of canals and flood by-passes.

Trained personnel were short not only because many were still in military employ but because there were many other irrigation projects of similar nature, even though smaller or of lower priority, requiring attention ; instruments were similarly short.

It became necessary therefore to convert one of our training parties at Abbottābād into an Irrigation Survey Training Party in which research was carried out in many possible methods and officers and men trained in those best suited to the various projects involved. With the close of the war the whole training organization at Abbottābād ( see *Training* ), augmented by as many experienced officers as could be made available, was concentrating on training personnel for these projects and forming the new civil units necessary to get them going. The intention was to decentralize to the circles concerned for the actual work, but centralized and standardized training was first required.

3. The main Kosi project, along with others of similar nature elsewhere in India, was put in hand in the field season of 1946-47. The necessity for this and similar projects resulted in practically doubling the pre-war strength of the Survey of India. See *Projects*.

## KULU

The settlement survey of 260 square miles of this district of the Punjab was taken up at the request of that Government in the field season of 1944-45 by a detachment under the control of the Frontier Circle. The work was very similar to that carried out in the Hazāra District of the N.W. Frontier Province ; the reasons for taking up this work in war time and the methods used are outlined under the heading *Hazāra*.

In the Kulu survey, *musavis* were plotted on the scale 20 *karams* to an inch, in this case about 57 inches to a mile the Punjab *karam* being different from the Hazāra *karam*.

The work was still in progress in 1946.

## KURRAM

This small settlement survey work is mentioned under the heading *Hazāra*.

## LAMBERT GRID

The map grid used on Indian maps is that based on the Lambert conical orthomorphic projection ; it was also used on many other maps series during the war and is particularly suited to areas of great size east and west in comparison to their size north and south. It is applicable to any map no matter on what projection the map itself is based.

The Survey of India had a very complete set of computation forms designed for carrying out surveys on this projection as well as the appropriate tables. Each east-west belt was subdivided into sub-belts to avoid excessive convergence inconvenience. The grid situation is more fully explained under the heading *Grids* ; the Lambert grid as used in India is explained in detail in the Survey of India Professional Paper "The Lambert Grid for India" and more briefly in the Survey Service Pocket Book, Part VI.

2. The International aeronautical charts designed by the United States Army were based on the Lambert projection, called in America conformal conic projection. See *Aeronautical Charts*.

## LAY-OUT OF MAPS

This subject involves the size and shape of map sheets, their bounding lines (spherical versus grid), their numbering system and their marginal information such as symbol tables, scales and the like.

It is discussed under head *Map Policy*.

## LEAVE

Members of the Survey of India, including its military members, earned and took leave under the Civil Leave Rules. Before the war, European members seldom took leave in India preferring to accumulate it over several years—admissible under civil rules—and then enjoy a long leave outside India ; Indian members too seldom took short leave but accumulated it so that they could take a long stretch of leave at one time to settle up domestic affairs or pending their retirement.

It had become almost a habit to refrain from taking leave (except casual leave for a week or ten days) for some years at a time.

2. This habit became detrimental to health and efficiency during the war years and the Survey of India adopted and encouraged a policy of sending everyone possible on leave for not less than one month per annum ; this policy was later adopted by the Government of India.

At the outset, we found it very hard to persuade officers and other ranks to avail themselves of leave opportunities ; the leave of course was debited to their leave accounts and the habit of

“saving” leave had become so ingrained that it was difficult to break. This was partly due to the much greater “overhead costs” in taking frequent short spells of leave, the civil services not granting cheap railway rates as did the army, except in a few cases.

Towards the end of the war, however, when officers and others had come to realize the advantages of annual leave, one of the big problems of the administrative offices of the Department was the leave roster ; to fit all in at the time most suited to them while still interfering with work to a minimum.

The results of our policy, however, fully justified it ; we had remarkably little sickness, considering the long hours of exacting work put in by all ranks.

3. In the earlier years of the war, officers in civil employ were not allowed to take leave out of India, partly because of shortage of transport partly because of the time involved ; few civil officer had “leave reserve” strength. Leave almost invariably meant someone left behind doubling up on his duties. In the Survey of India, containing a number of European military officers, the military war leave rules which allowed short visits to U.K. mostly by air, and “free” of transport cost to the individual, caused some dissatisfaction and jealousy ; the introduction by the Government of India of its “Key Leave” scheme did much to allay this, allowing as it did a proportion of each civil department to enjoy 4 months leave in U.K. with a priority passage to and from. A number of Survey of India officers were able to take advantage of this scheme.

Survey of India officers in military employ were able to take advantage of the military “Lilop”—leave in lieu of “Python” ; the latter term merely meant repatriation to U.K. after a given number of years service outside U.K. There was some controversy whether Survey of India officers were entitled to be repatriated, and hence to take Lilop ( unless they relinquished their lien on a civil appointment which they in fact held throughout their service in military employ ), but in the end it was possible to work out all cases satisfactorily.

Those availing of Lilop under army rules did, however, “score” off their confrères who happened to be in the Survey of India proper for the time being in that they got free passage to U.K. and back, whereas those in the Department did not. As far as possible, we tried to let officers in military employ enjoy their Lilop *before* returning to the Department.

4. Another difficulty was “War Leave”. Officers and men leaving the army for repatriation to India were entitled to war leave, based on their length of service in the army ; according to army rules, this leave must be taken before rejoining their civil appointments. There was naturally much reluctance to return to civil duty without first availing of this special grant of leave and this led to the Survey of India being short-handed just when the heaviest work was building up.



"Deferred Leave" was suggested to the Government of India and the Army by the Surveyor General; this was eventually approved.

5. There were various other complications in connection with leave particularly in respect of whether or not leave granted under military rules was to be debited to civil leave accounts.

A goodly proportion of our personnel in military employ seemed to think that leave granted by military commanders was "free" leave, not to be debited to leave accounts, overlooking the fact that military service was treated as civil service for the purpose of earning leave under civil rules. Leave granted by military authorities (except the equivalent of casual leave) was debited to civil accounts but for one or two authorized exceptions where the *intention* was to grant "free" leave as part of the terms of service.

## LETTER PRESS PRINTING

There were letter press printing sections in the Geodetic Branch offices at Dehra Dūn and in the Map Publication offices in Calcutta, the former being the more comprehensive; during the war it was decided to dispense with the Calcutta Section and correspondingly augment the Dehra Dūn Section to enable all technical publications to be printed at one place and to enable a reasonable quantity of up-to-date machinery, including book-binding machinery, to be acquired at least for one section.

A "Monotype" type casting and setting machine had been purchased shortly before the war, and another was put on order during the war not only to cope with letter press printing for which other machines might have been more suitable, but to put ourselves in the position of being able to cast our own type for hand-typing names on maps, the art of hand lettering having been almost completely lost in the Department during the years from 1905 onwards.

There are further details under *Plant and Machinery*. See also *Hand-printing*.

2. There had been objections off and on from the Stationery Department of the Government of India in regard to our possessing and operating letter press printing plant. During the war it was appreciated that a technical service such as the Survey of India required its own printing equipment and staff to deal with its technical publications quickly and efficaciously; the more so because charts and diagrams had very frequently to be incorporated in technical publications, that could only be prepared with sufficient clarity and accuracy by processes other than letter press printing.

3. A great volume of technical printing was handled by the Survey of India Sections during the war in the shape of Tide-Tables, Grid Tables, Lists of Triangulation Data (hundreds of thousands of points described by latitude and longitude or by grid co-ordinates or both), Lists of Bench-Marks, Mathematical Tables, Star Almanacs,

Pamphlets recording the results of scientific research ; and technical publications or re-publications such as the Survey Service Pocket Book, Topographical Handbook and so on.

Map footnotes also had to be set up in type to save time in hand-typing or printing ; it was essential that these be set up in our own offices under our own control.

The letterpress sections did most valuable work from all points of view and their reorganization into a single and reasonably modern section at Dehra Dūn did much to further the Survey of India, and the Indian, war effort. See Table K.

## LEVELLING

India had been covered by a comprehensive network of high precision levelling and extensions to this network were in progress in 1939-40. This work was dropped as war requirements supervened and no precise levelling was carried out during the war years though programmed for post-war mainly in connection with the *AID Survey* work, under which it is mentioned.

2. A large quantity of levelling was, however, carried out for war purposes mainly in connection with the lay-out of airfields, factories, arsenals, military barracks and camps and the like. Many of these works were executed by the *Cantonments Party* under which heading they are mentioned in more detail ; No. 12 Party of the Eastern Circle also executed a considerable amount of work in Assam in connection with the Ledo and neighbouring bases.

The Military Engineering Services and the P.W.D. also did a great deal of levelling work, based on Survey of India bench-marks and control circuits. Levelling data were supplied to these services through the medium of Survey of India "Levelling Pamphlets", published over the past many years and in some cases corrected during the war ; where necessary, manuscript data were supplied. This was the function of the Geodetic Branch, later the War Research Institute.

3. Irrigation, hydro-electric and flood control projects during the later stages of the war and immediately after it also involved a great deal of secondary and tertiary levelling and specially recruited trainees were taught this subject in the irrigation survey training units at Abbottābād. See *Training*.

The precision framework recorded in the Levelling Pamphlets also formed the basic control for all this work.

Apart from the Survey of India, many other departments such as the M.E.S., P.W.D. and Railways were in great need of levels after the war ; these instruments were therefore in very short supply and their supply had to be controlled centrally.

4. All Indian Survey Companies had levels in their war equipment. These were usually of the split bubble type. During the

war they had occasional use for them in connection with airfields, etc. After the war, these became available for civil purposes.

## LEVELLING DATA AND PAMPHLETS

See *Levelling, Projects, War Research Institute.*

## LIBRARIES

A comprehensive library of technical books existed in the Geodetic Branch at Dehra Dūn ; a more general one in the Surveyor General's Office, mainly in the old offices at Calcutta. There was also a small library at Murree.

A small library of foreign and exploration maps had been collected in the Geodetic Branch ; this was transferred to the Geographical Section, General Staff, and greatly augmented by them after 1942.

2. Up to 1942 there had been no comprehensive library of air photographs or negatives, though a large number were in existence in R.A.F. stations, in the Survey of India and in the offices of Messrs. Indian Air Survey and Transport, Ltd.

During 1942 a central library was set up by the R.A.F. in New Delhi to which all available photo negatives were sent and more added as photography proceeded. I.A.S.T. contributed all that were available with them, some thousands, mainly of eastern India and Burma. This was done under the terms of the Survey of India charter with them, outlined under the heading *Indian Air Survey and Transport.*

## LILOP

Leave in lieu of Python was a military leave scheme mentioned under *Leave.*

"Python" was a repatriation scheme for British Service military personnel ; this affected the Survey of India and is also mentioned under *Leave.*

## LOWER SUBORDINATE SERVICE

In this service a number of field and office "trades" was included and although not actually a part of the Lower Subordinate Service, map reproduction trades of corresponding status ( Division III personnel ) were similarly organized and on similar though not identical rates of pay.

Field trades were those of surveyor ( plane-tablet ), air surveyor, traverser, leveller, rectangulator, etc., and office trades those of draftsman, computer, clerk, etc.

Map reproduction trades were those of hand press printer, machine printer, photographer, negative retoucher, etc.

No trade pay as such was granted, except a small allowance to those who were qualified air surveyors. Trade pay was, however, eventually granted to those in military service, see *Trade Pay*.

2. Except clerks, men in the Lower Subordinate and Division III Services were not usually very well educated, being selected rather for their physical toughness and manual dexterity. Lower subordinates were recruited from much the same sources as the army recruited their rank and file.

The army ranks granted to men of the Lower Subordinate and Division III services on mobilization are indicated in Table B.

3. Promotion in these services was practically on a time basis until reasonable experience had been gained, though not rigidly so. In the higher ranks, promotion was almost entirely by merit. Army rank was based on civil rank and rate of pay.

A small number of Lower Subordinates gained promotion to the Upper Subordinate Service and from Division III to Division II of the map reproduction services.

4. In 1939 there were about 900 Lower Subordinate officers and about 300 Division III; in 1945 the respective numbers were about 1,960 and 525. About 630 of the two services were in military service in 1945, including "soldier surveyors". See *Soldier Surveyors and Services*.

## MACHINERY

This is dealt with mainly under *Plant and Machinery and Stores*. There was a vast increase in the machinery of the Survey of India installed during the war.

## MADRAS

The Government of Madras Presidency had for some years been issuing 1-inch maps which, though based on Survey of India original surveys, were maintained by the local government and republished by its survey department at quite frequent intervals.

2. During the war, this government placed its map publication facilities at the disposal of the survey services and a considerable number of maps were published by it both for the Survey of India and for the Director of Survey (India). In all, the Survey Department of Madras printed many thousands of maps.

3. Farming was otherwise little resorted to, owing to other local governments having only elementary facilities and the trade being little developed.

See also *Southern Army, South India Party*.

## MAGNETIC WORK

A great deal of original magnetic work had been carried out in India and Burma (described in the various Geodetic Reports)

but although observations continued to be made in the magnetic observatories in Dehra Dūn, little repeat field work had been done and our values were somewhat out-of-date.

The magnetic declination (later called "variation" see para 4) on our maps of India and Burma was deduced from these old values; for maps outside India and Burma we relied considerably on British Admiralty information and in later years on information from Australia.

2. The latter information indicated that there were anomalies in our values and in 1943 a repeat field programme of observation was carried out, mainly in eastern and southern India, which enabled us to adjust our values at least in those areas to conform closely with Admiralty and Australian values.

Repeat field programmes were continued thereafter and the Government of India agreed to include a Magnetic Scientific Officer in the personnel of the War Research Institute and also to finance regular repeat programmes in the future. See *War Research Institute*.

3. Some magnetic work was also done in connection with the search for minerals during the war. Certain instruments were transferred to the Geological Survey of India in this connection.

4. The discrepancy between true north and magnetic north is properly called the magnetic *declination*, the term *variation* properly describing the amount by which the declination varies with time.

In order to conform to American military practice, however, it became necessary in the latter part of the war to use the term *variation* to mean *declination*. All our later war maps are therefore annotated "Magnetic Variation so and so" instead of, as in the past, "Magnetic Declination so and so".

## MAHĀNADI

The Mahānadi River flows eastwards from the highlands of the Central Provinces through the southern portion of the province of Orissa and empties into the Bay of Bengal some 200 miles south-west of Calcutta. The control of this river for floods and its utilization for irrigation and hydro-electric works was one of the major post-war reconstruction projects in which the Survey of India was involved; apart from surveys for reservoirs and dams, some 2,500 square miles of 4-inch survey was required somewhat on the lines of the Kosi and Tista River projects, also mentioned under those headings. The Mahānadi project had a very high priority in post-war works and like the Kosi and Tista required special organization and training to carry it out reasonably cheaply and expeditiously.

Organization for this project commenced some time before the war ended. The general set-up of post-war works is discussed under the heading *Projects*.

**MALAYA**

There was a strong survey department in Malaya with headquarters at Kuala Lumpur, of which Mr. W. F. N. Bridges was the Surveyor General. This department devoted considerably more time to cadastral and revenue matters than did the Survey of India, but there were excellent maps of a considerable portion of the Peninsula which, though not designed as military maps, were gridded. (Cassini, separate grids for the northern and southern portions of the Peninsula). These were on a spherical lay-out, like Survey of India maps.

There had been little direct liaison between Malaya and India before the war.

2. When Japanese intervention in the war seemed imminent, Major H. W. Wright, R.E., Officer-in-charge, Burma Survey Party, was sent to Malaya and Netherlands East Indies to establish liaison and ascertain the map and map publication position; at the same time, he reconnoitred the approach to Rangoon via Moulmein from a survey point of view. See *Burma Survey Party*.

Early in 1941 a conference was held at Delhi between Mid-east, India and Malaya on survey matters, attended by Mr. Bridges. At this conference map policy was decided and arrangements made for all possible mutual aid in map publication and other survey matters, including the exchange of "material" for the preparation of maps (see *Black Print Originals*) and the training in India of four officers of the Malaya Survey Department in military survey work as practised in India.

3. Soon afterwards four officers, Messrs. Booth, Bruce, Stubbs and Greig, arrived in India and spent about six months under training in military and air survey in Risālpur/Murree in the Frontier Circle. They returned to Malaya just after the Japanese had entered the war and formed military survey units there, only to be captured with the fall of Singapore.

During 1941, Lt.-Colonel G. W. Gemmell, I.A., was sent on special duty to Malaya (Singapore) to assist the Malayan Survey Department in organizing military units and military map publication and to discover the latest information on the map and survey situation there.

4. After the Japs had overrun Malaya, the connection of the Survey of India with that country was in the preparation of maps, tide-tables, trig. data, grid data adjustment, etc., in preparation for invasion and re-occupation and finally, in supplying units or personnel to reinforce existing units that would operate in that country.

5. It was with great regret that the Survey of India learned that Mr. Bridges who escaped to Java on the fall of Singapore was later lost at sea, on evacuation from Java, when the ship in which he was travelling was sunk by the Japanese.

## MAP CATALOGUES

The Survey of India map catalogues showed all maps published by the Survey of India as Government of India maps ; they did not show maps published for the army, for which separate catalogues were prepared by the Geographical Section, General Staff. The former was arranged in standard Survey of India series, the latter in terms of the military HIND series.

There was also a catalogue prepared by the G.S.G.S. at the War Office, showing the various series prepared by them.

2. The Survey of India catalogues provided, in themselves, a very useful atlas of India. Burma had been included originally but this was dropped with the separation of Burma from India in 1937.

In the method used before the war, it was very difficult to keep catalogues up to date in respect of new maps published on topographical scales. For this reason, a new system was evolved and a new catalogue published in 1945. This catalogue contained a single index to sheets published on one-inch, half-inch and quarter-inch scales, that could readily be reprinted annually or as often as required.

## MAP CLASSIFICATION

Maps not available to the general public had been classified as "For Official Use Only" ( F.O.U.O. ) like many documents issued in India. About the start of the war, such documents were reclassified in Britain as "Not to be Published" ( N.T.B.P. ) ; this new classification was followed by Burma but not by India.

Finally, maps of this nature were classified as "Restricted".

*See For Official Use Only.*

## MAP COSTS

Early in the war it was found impossible to carry out any form of cost accounting in respect of either drawing or publication. Map sales were therefore flat-rated, which is discussed under heading *Map Sales*.

## MAP DEPOTS

The main "map depot" of the Survey of India is the *Map Record and Issue Office*, which is described under that heading. All circles and some parties also hold stocks of maps, mainly for local issue. During the war, the Frontier Circle held stocks for Northern Command ( N.W. Army ).

2. Before the war there was a central mobilization map depot under the control of M.I. 4 at Army Headquarters, with smaller depots at the headquarters of Commands and some Military Districts.

Maps were replenished when required from the Survey of India M.R.I.O. In the early stages of the war, maps were generally supplied direct to the troops requiring them either from the M.R.I.O. or direct from the publishing office. See *Map Issues*.

With the formation of the Geographical Section, General Staff, a *Central Map Depot* was built up in Delhi under its control and normal procedure was to send the bulk of maps published to this depot for storage and further distribution. In some cases, maps were sent direct from the publishing office to forward military depots.

3. Map distribution and storage in the field was carried out by *Map Supply Sections*, military units originally mobilized from Survey of India personnel, later formed directly by the Director of Survey ( India ), or by a mixture of Survey of India and non-Survey of India personnel.

A special improvised section formed in *Burma* is mentioned under that heading.

The distribution system is illustrated in Plate IX ( Page 181 ).

## MAP DISTRIBUTION

See *Map Issues*.

## MAP DRAWING

See *Fair-drawing*.

## MAP ISSUES

In peace time, map issues involved comparatively large numbers of different individual sheets but small quantities of each sheet; the average number of copies printed of each Indian map sheet was about 500, as compared with printings during the war running into many thousands. A completely different system for issue and distribution of maps was therefore required to meet war demands and far more storage space was required. The Survey of India, however, had at the same time to maintain its peace-time system of detailed issue to meet the requirements of individual indentors demanding one copy each of a number of sheets, or even of a single sheet.

The Map Record and Issue Office of the Survey of India was well organized to deal with individual issues, not so well organized to deal with issues in bulk. The military map issue organization at A.H.Q. and Command H.Q. was in similar state, for forces employed in Frontier "shows" and the like were small and maps, before the war, were not issued on the lavish scale that grew up during the war.

2. It had been recognized by the Survey of India that map issue in a full scale modern war would be a tremendous problem and that storage and transport would present problems of major



importance—about 30,000 small size maps go to a ton—but the real magnitude of the problem had not been recognized.

While the inclusion of Map Supply Sections in our pre-war war establishments, with a fair amount of transport, did go far to meet the field distribution problems, they did not meet the bulk storage and bundling and bulk issue problems.

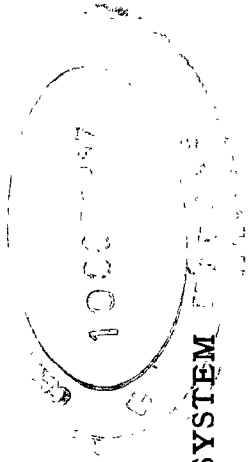
Pre-war military organization for map distribution was quite inadequate, as is illustrated by the failure of maps to reach the troops in Burma ( see *Burma* ) ; our organization for the handling of bulk was quite inadequate as forces increased in size. When a large number of printing machines capable of turning out about 4,000 map sheets per hour are in full action, there is a good deal of paper about—in store, in the printing office waiting to be printed, under printing, in the office waiting to be put in map store and finally in the map store itself. The maps printed by the Survey of India alone during 1944-45 weighed approximately 750 tons ( excluding “spoils” ) and represented a stack of paper not much less than a mile high ; the military survey organization in the Eastern Theatre produced approximately the same volume and weight of maps.

3. When bulk demands began to become large, starting with the supply of ‘Irāq and Irān maps and later Burma maps, it became necessary to clear printed maps quickly ; our available storage could not contain them, nor could the storage available in A.H.Q. or elsewhere. Maps had therefore to be cleared in bulk to the forces demanding them. This of course also saved time, but did make for some difficulty at the receiving end.

The formation in 1944 of the military Central Map Depot at Delhi besides sub-depots at other places eased the situation considerably. The Central Depot had storage for about 15,000,000 maps ; the building of the new Survey of India offices at Hāthibarkala not only provided a very large amount of storage space for both paper and maps but also allowed the old M.R.I.O. storage in Calcutta to be made available in part for a military sub-depot in that place.

Other storage depots were used in Calcutta both by the Survey of India and the army, for both paper and finished maps, partly to obtain sufficient space, partly to ensure dispersal against bombing.

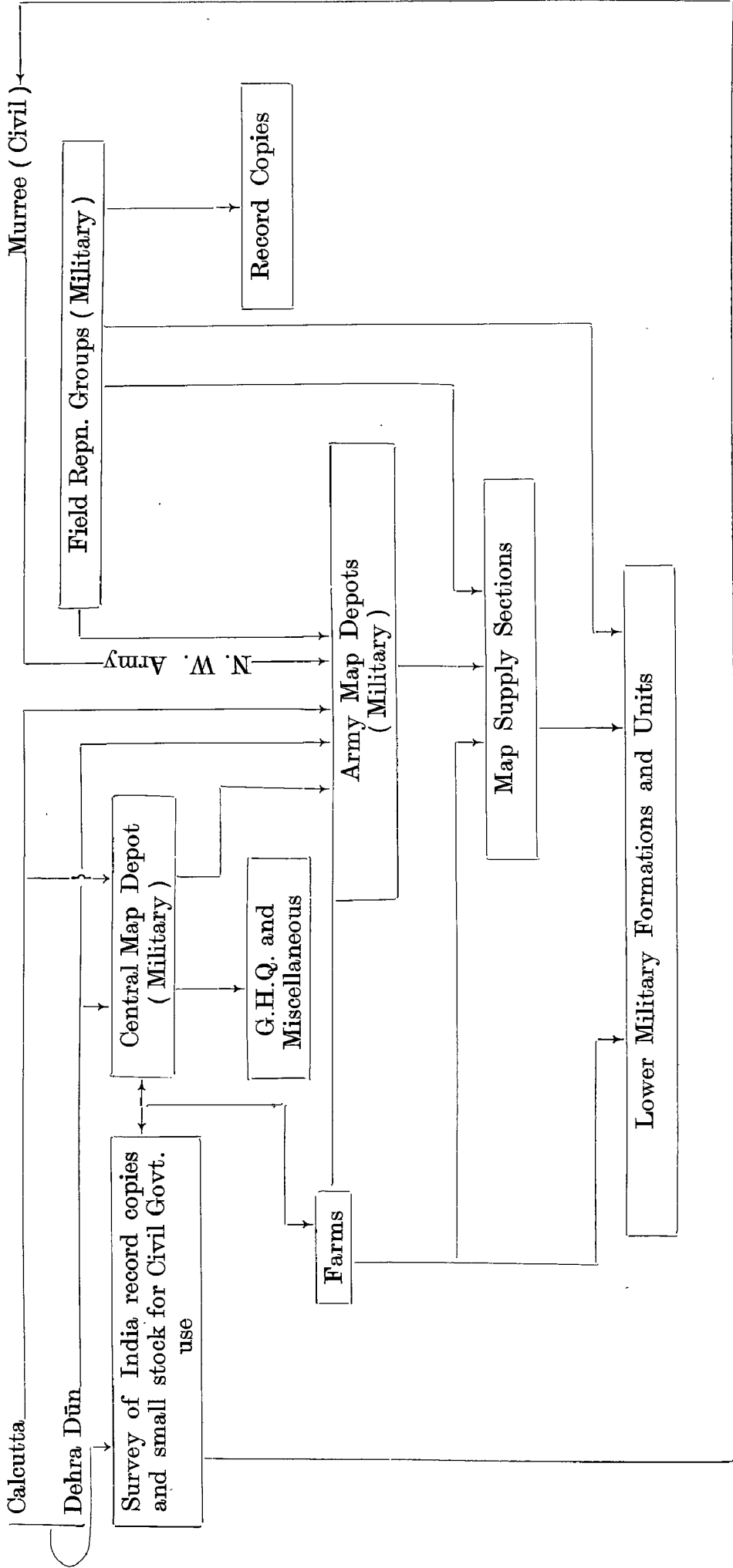
4. Before despatch to forward depots, maps had to be bundled or otherwise packed to stand rough transport ; this was mainly done at the Central Map Depot in Delhi maps being sent in bulk to it from the printing offices in Dehra Dūn, by lorry. An ingenious scheme of bundling was devised, easily carried out by map *khalāsīs*, which kept maps in good condition in transit while at the same time enabling them to be bundled in hundreds or other prescribed numbers, and stored ready bundled on the shelves. The method is known as the “*String Method*”. A core is made by rolling about 50 copies of the map as tightly as possible and to it are attached three lengths of twine with loops at a suitable distance,



MAP DISTRIBUTION SYSTEM

BASE PRINTING OFFICES

MOBILE PRINTING OFFICES



learnt by experience. The ends of the twine are fixed to nails in the floor to keep it tightly stretched. Then a pile of about 400 maps is placed on the twine in front of the core and slid forward over itself till there is a tapered edge up which the core can be rolled easily and tightly by two men ; these can be followed by more maps in lots of 100 till a total of about 1,000 is reached, when the loops in the twine are caught up under the turns on the outside of the completed bundle and the loose ends ( cut free from the nails ) securely fastened to them. The bundle is then wrapped in waterproof brown paper and stitched up in gunny on which the address has already been stencilled. Boxing was also used but was more costly, more bulky and, if anything, less efficient in protecting the maps from damage. Wood also was in short supply ; gunny for bundling was readily available, and string.

A system of coding was also devised ( with which, however, the Survey of India had no concern ) to ensure that secrecy was maintained while at the same time the correct maps were placed aboard any invasion ship.

When there was time, or when an excessive volume of maps was involved, it was convenient to send all maps to the military Central Map Depot at Delhi. In cases where a proportion had to be sent direct from the Survey of India printing offices to forward depots or to the troops themselves, bundling had to be done in the Survey of India office concerned ; space had to be available for this work.

5. The map issues are detailed in Table J and the distribution system is illustrated in the diagram facing this page. ( Plate IX ).

The Survey of India continued to use its normal peace-time system, through the M.R.I.O., for issues to local Indian indentors, whether for Government Departments or private individuals. See also Chapter III and *Map Publication*.

## MAP LAY-OUT

See *Map Policy*.

## MAP LIBRARIES

See *Libraries*.

## MAP MAINTENANCE

“Maintaining” a map consists in keeping it up to date not only in the material included in it but also in style, colours to conform to the latest practice for maps of its type and marginal information like magnetic declination and so on.

This is a very serious difficulty even in peace time especially in areas that are developing fast, areas that are newly canalized, etc. In war, it may present an even greater problem for enemy works—and those of our own forces—may be so extensive and so rapidly

constructed as to make a map even a few weeks out-of-date not only useless to the troops but a positive danger to them.

2. Air photographs of course provide the simplest and quickest means of obtaining information from which to correct an existing map ; assuming reasonably well trained air survey personnel they also provide the simplest means of applying the new information to the map. By whatever means the information is obtained and applied to the map records, however, it still remains to republish the map which may involve complete re-photography with all the attendant tasks and must involve a complete reprint in the full number of colours decided upon—usually though not always implying passing through the printing machines once for *each* colour. ( Multi-colour machines of course obviate this to some extent ).

Whether corrections are applied to the fair original ( involving complete re-photography ) or to the photographic negatives or to the zinc printing plates themselves depends on the volume of the corrections, the time available and the skill of the men trained to work on glass or zinc as the case may be. Each case has to be decided on its merits.

Fortunately, considerable thought had been given to this problem very shortly before the war and we were better equipped to deal with it than we might otherwise have been.

It was because of this problem that a decision had been made to publish our standard maps in black and brown only, at least for some time, to catch up on outstanding maintenance necessities. ( See *Map Policy* ).

3. There is an attendant problem to map maintenance, that of ensuring that all troops are using the *same* map ; that is, if a new edition incorporating late information has been issued, that all troops not only have it, but are in fact using it.

In the 1914-18 war, "appliqué slips" were frequently issued, covering sections of a map that had been revised ; they were intended to be pasted on—some were and some were not, with resulting confusion in orders as well as map reading as such. These were seldom used during the 1939-45 war ; instead, a completely new map was prepared which was one of the reasons why so much map printing was required. This, however, is an essential in a war of global magnitude, and it is equally essential that each map shall have clearly marked upon what edition it is and that it shall be made clear to all troops what edition they are required to use.

Furthermore, it had to be possible for *identical* maps to be prepared ( say ) in America, Britain, Mid-east and India ; to achieve this, what were called "Black Print Originals" ( B.P.O's. ) were exchanged between the various countries, being initiated by the country initiating the new edition. This enabled troops from America to arrive in a theatre equipped with precisely the same maps that were possessed by Indian troops and may have been initiated in India.

B.P.O's. were merely clean black prints on very good quality paper, from which photographic negatives could be made and applied to zinc in the usual way. In some cases, film was used instead of paper, but for a long time film was in short supply. See *Black Print Originals*.

4. Except very early in the war, the Survey of India was little concerned with collecting information for maintaining maps outside India's borders or in eastern or southern India this task being performed by the military survey units concerned and in the case of operational maps applied to new editions on the spot; in the case of long-term mapping projects, the information was supplied to the Department by the G.S.G.S., sometimes in the form of compilations ready for final fair-drawing, or even for photography as they stood.

Information continued to be collected in India for maps in other than operational areas, though there was little opportunity to apply it except in special areas of military or post-war reconstruction importance.

A considerable maintenance task awaited the Survey of India at the end of the war. that will take many years to complete.

## MAP PAPER

See *Paper*.

## MAP POLICY

Map and survey policy are of course intimately connected; no specific discussion of the latter has been made except what will be found in *Air Survey*, *Grids*, *Plane-tabling* and *Triangulation*.

2. Map and to some extent survey policy was laid down in 1906 following the recommendations of a strong committee that assembled in India in 1905, made up of senior representatives of the Government of India, the Army in India, the Survey of India and the Ordnance Survey of Britain. The policy then framed was followed with relatively minor modifications until the 1939-1945 war and when that war broke out, India and also Burma were reasonably well covered with post-1905 topographical maps on 1-inch,  $\frac{1}{2}$ -inch and  $\frac{1}{4}$ -inch scales—though these were more out-of-date than the original policy envisaged, due to financial stringencies from time to time—and also with good series of maps on the geographical scales of 1/1 Million and 1/2 Million. There were also many town guide maps on various scales from 1/25,000 (about  $2\frac{1}{2}$ -inch) to 6-inch and a number of "Radius and Manœuvre" maps mostly for military training purposes.

These maps had been prepared mostly from plane-table surveys based on triangulation or traverse, in turn based on very high precision geodetic triangulation; in some special cases and on the N.W. Frontier particularly, the maps had been prepared from air

surveys based on whatever trigonometrical or other control was possible in the area concerned, or desirable for the purpose concerned. There was no special military map series as such. See para 4.

Maps had also been compiled on  $\frac{1}{4}$ -inch and geographical scales, following standard Survey of India layout, colouring, etc., of Afghānistān, Irān and 'Irāq and geographical maps covered Ceylon. See *Afghānistān*, etc.

3. Before 1905, maps had been mainly in black only and hachured instead of contoured ; sheet sizes in the 1-inch ( the main standard ) series were also somewhat unwieldy, covering  $\frac{1}{4}^{\circ}$  north and south by  $\frac{1}{2}^{\circ}$  east and west.

After 1905, all maps were required to be contoured, all were in a number of colours and all were approximately to the same size on scales between 1-inch and 1/1 Million ; thus the 1-inch maps covered  $\frac{1}{4}^{\circ} \times \frac{1}{4}^{\circ}$ , the  $\frac{1}{4}$ -inch  $1^{\circ} \times 1^{\circ}$  ( hence their name, "Degree Sheets" ) and so on ; except that after the Carte Internationale du Monde ( International Series ) on 1/M scale was introduced in 1913 this series, following the layout prescribed internationally, covered  $4^{\circ} \times 6^{\circ}$  and the other geographical series, 1/2M, conformed in size being  $8^{\circ} \times 12^{\circ}$ .

The topographical and the 1/M I. and A.C. maps were thus about  $24 \times 19$  inches in size, while the other two series were about  $34 \times 22$  inches, including marginal information in both cases. Marginal information consisted of symbols tables, height tables, scales, footnotes, etc. Samples of maps are in the pocket at the end of the book.

The maps were laid out on spherical sheet lines of course and were numbered on an arbitrary system in the case of the topographical and I. and A.C. series, and on the international system in the case of the Carte Internationale du Monde ; see *India and Adjacent Countries Series* and *International Series*, and Chapter III.

4. As mentioned in paragraph 2, maps were somewhat out-of-date before the war and much consideration had been given to the problem of maintaining them, see *Map Maintenance* ; furthermore, nearly one quarter of India still remained to be covered by post-1905 surveys though old style maps existed of this area. It was therefore decided in 1938 to reduce the number of map series produced by dropping the I. and A.C. series in favour of the International, instead of keeping both up and by dropping the  $\frac{1}{2}$ -inch series except where the 1-inch did not exist ; and it was also decided to limit colours to black and brown only ( plus blue in certain cases ) until we could catch up with maintenance ; as explained under *Fair-drawing* our drawing system lent itself well to this economy of time.

Maps in areas of military importance were gridded but the majority of maps were not, see *Grids*. Few maps had been made *ab initio* in grid terms, however, except for purposes of training in military survey methods.

5. It will be noticed that some maps were on inch scales and others on natural scales ; and that the numbering of Survey of India maps was based on the obsolescent I. and A.C. system instead of the newer International system. A change to natural scales throughout had been considered from time to time and also a change in numbering to conform to the International numbering ; the problems in doing so were, however, of such magnitude that they were difficult to face even in peace and in war it was quite out of the question to do so. See *Map Scales, India and Adjacent Countries Series*.

The 1/25,000 scale was frequently used for town guide and similar maps and was the normal scale for military surveys where a scale larger than 1-inch was required.

6. The policy outlined above changed little during the war so far as Survey of India maps were concerned except that, as drawing power and publication power increased, so the "black and brown only" policy was abandoned and maps were produced in more and more colours, though not so many as pre-war ; and all maps published were gridded at the out set.

The Survey of India International Series was allowed to follow army changes in policy and one particularly pleasing map resulted, see map in pocket at end of book ; some, however, were terrible as were many of our own black and brown. In all maps specially prepared for the army, their requirements were followed ; a new series prepared for them, Hind 5001 which is an air approach as well as ground communications map should be a useful addition to the Survey of India standard series. This map is on the scale of 1/500,000 and is very boldly drawn with relatively little detail shown and hence is readily readable from the air or in a moving vehicle.

7. At a conference in Cairo in 1940, it was decided to lay out the maps of 'Irāq and western Irān, then under survey by military survey units, on grid bounding lines instead of spherical. This policy has advantages but, particularly on the smaller scales, has obvious disadvantages and eventually was dropped in favour of spherical bounding lines followed in 'Irāq/Irān and elsewhere for the remainder of the war except for very large scale battle maps.

A number of different foreign map series were republished by the Survey of India during the war, see *Map Publication, Indo-China*, etc. and *Hind Series*. These were published to military specifications and policy, the major repercussions on the Survey of India being the very heavy drawing and sometimes photographic work required, and the computations to apply our own grids and convert longitudes to Greenwich and degree terms from Paris and grade terms.

8. Post-war map policy had not been decided up to 1946 but geological and other reconstruction activity suggested that, at least in a good part of India, larger scales than in the past would be required. See *Projects*.

## MAP PUBLICATION

The bulk of map publication in the Survey of India had been done in the Map Publication Office, part of the headquarter offices of the Department at Calcutta. A relatively small amount was done in the Photo-Zinco Office at Dehra Dūn under the control of the Director, Geodetic Branch and still smaller amounts were done in No. 18 ( Air Survey ) Party and "E" Company of the Frontier Circle, mainly to meet local requirements.

This picture changed considerably during the war, the main map publication office moving to Hāthibarkala ( Dehra Dūn ) while still retaining the old office at Calcutta, the Geodetic Branch P.Z.O. being greatly expanded and the reproduction sections of 18 Party and "E" Company being amalgamated into a considerably more powerful unit at Murree.

The development of the main map publication office as such is described under the following heading, *Map Publication Circle* ; the expansion of the other offices under *Geodetic Branch* and *Air Survey Party*.

2. The majority of maps were produced by the photo-zinco process, the vandyke process, however, being used for a number of non-standard series maps, where cheapness was more important than high quality. Lithography on stone was no longer used except in the Army Section of No. 6 Drawing Office at Simla which, however, printed only special maps for the army, no standard Survey of India maps or civil maps.

Nearly all photography was on wet plates, room cameras being mainly used though some portable cameras were also in use ; we had no automatic scaling cameras such as the "Monotype" camera, scaling being done by measurement with paper strips. At the end of the war, however, a Monotype camera was on order, for Hāthibarkala. Film was used, mainly in No. 18 Party, for special work, panchromatic dry plates only to a very small extent.

Duffing on glass negatives duplicated by the powder process was heavily relied on for colour separation, which was consequently slow ; this was our main bottleneck in maintaining maps and hence one of the main reasons for adopting the black and brown policy mentioned in the preceding heading *Map Policy*. See also *Map Maintenance*. Drawing on separate originals was in use to some extent but paper distortion made difficulty ; drawing on metal had so far not proved satisfactory. See *Fair-drawing*. For some series, glass negatives were kept "standing" but our supply of glass was not very large, nor was our storage for it. Zinc plates similarly were kept "standing" for certain maps but these were not very satisfactory where heavy orders for reprints were received, as in the war. A single plate will stand only a limited number of pulls from it.

Much of our war reprint work had therefore to be done *ab initio* by re-photographing paper originals.



3. At the start of the war, the Survey of India had no automatic-feed printing machines, though five were on order, and only six rotary machines (hand-feed) of which four were earmarked for mobilization on lorries or trailers if necessary; the balance of our printing power consisted of ten flatbed presses plus one in the Army Section.

Runs were normally small averaging 500 or less, seldom exceeding 1,000 or 1,200 see Table J; the machinery available was ample for peace time needs, but was very old and much of it nearly worn out. For this reason the five modern machines had been ordered. We had, however, no men trained in their erection or use.

By the middle of 1945, machine power was as follows :

Auto-feed 2-colour quad-demy	..	2
Single	..	5
2-colour double-demy	..	6
Single	..	6
2-colour demy	..	2
Hand-feed double-demy	..	8
Flatbed presses	..	4

For further details see Table H.

4. In 1938-39, the Survey of India (excluding the Army Section) printed 721,000 maps; in 1944-45, 22,075,000 maps roughly a thirty times increase. Some statistics are given in Table J.

Though the Survey of India strength of map reproduction personnel increased from about 320 in 1939 to about 550 in 1945, it would have been quite impossible to bring about the huge increase in map publication without outside trained help. Practically none was available in India, the map printing trade being little developed, and it was therefore necessary to obtain help from Britain in the shape of British Army personnel, see *Cadres* (B.O.R. and Officers). These officers and B.O.R.'s not only carried out the erection of most of our new machinery and operated it but also trained a considerable number of Survey of India men in its use. By the end of the war, the Department was able to stand on its own feet in the use of modern machinery and equipment.

5. So far as possible, Indian made paper, chemicals, inks and other materials were used; even so the majority, except paper, had to be imported, using a considerable amount of sea transport. After the first year, however, no paper was imported, all maps being printed on Indian made papers of bamboo or grass furnish, mostly the former, known as "Super-calendered Ahmedabadi" obtained from Titāgarh near Calcutta. The bamboo came from the forests of Assam and Eastern Bengal. It has been mentioned elsewhere that the paper used by the Survey of India alone during 1944-45 represented a stack nearly one mile high. See *Map Issues, Paper*.

6. The map publication power of military survey units increased concurrently with Survey of India expansion, though starting a

little later. At the outset, practically all map publication had to be done by the Department ; gradually more and more was taken over by the military units both in and out of India. Policy was for the military units to deal with immediate operational and short-term requirements, for the Survey of India to deal with long-term requirements and large size maps and multi-colour maps besides of course maps of India itself of the standard series. See *Map Policy*.

Some "farming" was resorted to, particularly to the Madras Survey Department which had for some years been producing topographical maps, based on Survey of India maps, for its administration. See *Madras*. There was, however, little other scope for this because the map printing trade was little developed in India.

Mention of map printing power in neighbouring countries is made under *Ceylon* and *Malaya* and *Burma*. The two latter were of course able to do nothing during most of the war.

7. Peace-time publication procedure was to send plane-table sections to Calcutta ( or Dehra Dūn ) for photography and preparation of black copies which could be pasted up together to form a mosaic for re-photography to correct scale for fair-drawing ; fair-drawing "blue-prints" ( cobalt powder dusted on almost colourless "ink" ) were returned to the units concerned for carrying out the fair-drawing process. The finished fair originals were returned to the publication office, usually Calcutta, for final examination to ensure they followed Departmental rules, etc., correctly ; they were then again photographed to publication scale, colour separation was carried out, usually by the duffing method, the various negatives were helioed on to zinc, and the zinc plates put through the machines. Numerous guides, proofs and so on were required. The process was inevitably very slow and it was seldom that a map appeared within 18 months of the time its survey had been completed. See *Fair-drawing*.

8. This procedure resulted in accurate and pleasant maps, but would hardly do for the rush of war work. Every possible time saving device had therefore to be employed in the war ; drawing had to be quicker and hence bolder ( indeed bold drawing may be preferred in war ) ; examination had to be quicker and hence less meticulous ; colour separation had to be speeded up and hence "separate originals" used introducing registration errors, and less colours used ( making a saving both in separation and in printing ) making a less pleasant and easily readable map. The end result was inevitable that map quality deteriorated.

Deterioration was accentuated by the fact that some 50% of our most experienced officers and men were transferred to military employ.

The military survey units had similar problems ; they had to get maps out even more quickly than did the Survey of India, for immediate operational purposes. Military series were therefore designed to take minimum time in publication and their methods developed accordingly.



Plate VI



Original drawing Capt. Rowlands, R.E.,  
reproduction Hāthibarkala Litho Office.

Colour Zincography



9. The foregoing paragraph is not intended to suggest that good work could not be or even was not done ; when time permitted some very fine work was done, particularly in connection with colour reproductions required by the Information and Broadcasting Department, under which heading this work is outlined. The work for that Department was done partly by the British technicians, but a large portion of it was done wholly by Survey of India personnel under the supervision of Captains Hodgkinson and Rowlands, R.E. ( E.C. ).

This work was of the very highest quality and of great difficulty being the accurate copying in colours of original colour paintings and sketches. A sample faces this page.

Maps, however, were seldom up to pre-war standards, simply because of the time factor.

10. In the early stages of the war, demands for maps were made by the Director, Frontier Circle or sometimes direct by A.H.Q. and Air H.Q. on the Director of Map Publication at Calcutta, the latter officer deciding whether to publish in Calcutta or in Dehra Dūn or in both places ; maps were despatched direct to the military formation demanding them by the Map Record and Issue Office in Calcutta or by the equivalent organization of the Geodetic Branch.

When the Geographical Section, General Staff was set up in 1942, all military demands were required to pass through the Director of Survey ( India ) ; this officer in his capacity as Director Military Circle of the Survey of India was authorized by the Surveyor General to make his demands on the Director Map Publication in the form of an order to publish, signed by him on behalf of the Surveyor General.

Special demand forms were devised ( see *Green Demands* ) which served the double purpose of an order to publish, giving the requisite instructions as to number of copies, colours, when required, etc., and also a voucher acceptable to the audit offices concerned to authenticate map sales transactions. ( See *Map Sales* ).

11. With the opening of the Hāthibarkala publication offices in Dehra Dūn and the move to that place of the Director, Map Publication in 1943 publication procedure became much easier not only because of the concentration of most of our power in Dehra Dūn—the P.Z.O. had by this time expanded greatly, apart from the new offices—but also by reason of the Director, Map Publication being so much closer to Delhi and readily available for conferences and telephonic discussion ; the telephone communication with Calcutta not only was not very good, but the lines were very congested with military and other Government traffic.

The Director, Map Publication was responsible for allotting work to his own Hāthibarkala or Calcutta offices or to the Geodetic Branch P.Z.O., according to head of work in the various offices, the size and scope of the machinery at their disposal and where glass, zinc or paper originals happened to be stored.

As the war progressed, we obtained large quantities of new glass as well as much increased storage space and hence were able to keep much more glass standing, for reprints or correction, than had been possible in the past ( see para 2 above ).

12. Length of runs greatly increased as the size of forces increased in the Eastern Theatre ; this is illustrated in Table J. Our black and brown policy was abandoned in favour of a limited number of colours as soon as expansion in plant and personnel permitted and most of the later maps were in a number of colours ; colour design was usually fitted to the particular series being dealt with at the time and no fixed colour policy developed. The 1/M series changed colours a number of times, as editions followed one another.

The handling of printed maps is outlined under *Map Issues*.

13. In the later stages of the war, it became necessary to divorce the Director, Map Publication from his routine map publication duties so that he could devote his whole time to planning production. A special post of Director of Planning ( Maps ), "D.P.M.", was created having Director's status and was additional to the regular post of Director, Map Publication. The planning staff worked with this Director, the organizational publication staff with the Director, Map Publication.

14. Other details will be found in Chapters III and VI and VII 89-92, VIII 113-116, IX 132, 133, X 149-153 and XI 162-165.

## MAP PUBLICATION CIRCLE

Before the war the main publication offices in Calcutta were called the "Map Publication Office". I have herein called this directorate a "Circle" because of its great expansion and its dispersion between Calcutta and Dehra Dūn, and also the expansion of other publication "offices" in the Department.

This heading should be read with *Map Publication* and *Hāthi-barkala*.

2. At the outset of the war, the Director, Map Publication had under his control No. 1 Drawing Office, the Photo-Litho Office, the Map Record and Issue Office, the Engraving Office and the Mathematical Instrument Office ; the latter was transferred to the control of the Supply Department in May 1941, see *Mathematical Instrument Office*.

For some years there had been talk of removing the publication offices from Calcutta to Dehra Dūn or some other place nearer Delhi but this had never been done though the Surveyor General moved from Calcutta to Delhi in 1939 and his office followed in 1940. The war started therefore, with the Surveyor General in Delhi and almost its whole publication power and its publication Director in Calcutta.

3. This was not particularly inconvenient during the early stages of the war ; in fact it was very convenient during the retreat

and evacuation in Burma. But from that time onward, it was extremely inconvenient as map demands increased by leaps and bounds to have the Director, Map Publication so far away from Delhi, the Survey of India and military survey headquarters, and from Dehra Dūn, the Geodetic Branch publication office by this time rivalling Calcutta in size and production.

When Calcutta became subject to dim-outs and then black-outs and time and energy began to be wasted in A.R.P., fire-watching, etc., a move elsewhere, or a second "map factory", was seriously discussed between the Surveyor General and the Government of India. The bombing of Calcutta, though no damage was done to us, decided it; we could not afford to have 50% or so of the total map publication power of India wrecked by a chance bomb.

The development of the new factory is outlined under *Hāthibarkala*, where the Director moved his headquarters in the latter part of 1943.

4. It had originally been intended that the Calcutta publication office should move, lock, stock and barrel, to Dehra Dūn. In the event, however, the vast increase in map demands and the recession of the Japanese air threat led us to modify this plan and to retain the Calcutta offices at or near full strength—towards the end they were even stronger than before the war—while at the same time expanding the P.Z.O. in the Geodetic Branch and building the new factory at Hāthibarkala. To start off Hāthibarkala, however, and keep it going, a large number of officers and men had to be transferred from Calcutta; this caused a considerable administrative problem, see *Bengal*.

By the end of 1943, map publication potential had very greatly increased in the Map Publication Circle, which had also been split into two, each original Calcutta office having been practically duplicated, except the Engraving Office; the Circle headquarters had transferred to Hāthibarkala, and the steel shelving in the Calcutta M.R.I.O. had been pulled down and was under re-erection in the much more spacious M.R.I.O. at Hāthibarkala the resulting space in Calcutta being utilized by the military survey service for their map sub-depot.

Expansion in personnel was carried out mainly by recruitment of untrained men and training them; a few men had been requisitioned from the trade, but the rates of pay demanded were so much higher, skill for skill, than received by our men that we had to use great caution on this account and indeed it was hard to find men in the trade, little developed, that were at all up to the standard we required. Shortages were made good by the B.O.R. Cadre who also provided the supervision necessary to operate the expanded offices pending training up of sufficient Indian supervisory staff. The British Officers' Cadre also provided higher supervision.

5. The considerable storage space allowed for in Hāthibarkala did much to ease difficulties in respect of the great quantities of paper in particular (both before and after printing) and of other

materials such as chemicals and inks as well. The construction of 13 buildings to house survey and map publication stores in the Geodetic Branch compound also made a great difference ; being in Dehra Dūn, reserve supplies for both the major publication offices were thus readily accessible in addition to the current supplies they could hold in their own storage.

Map storage in the new M.R.I.O. was also considerable ( for about 4,500,000 maps ) and the establishment of the military Central Map Depot in Delhi in 1942-43 added much to overall map storage space. Storage depots for both paper and maps were also established in hired buildings in or near Calcutta, partly under civil, partly military control.

As explained under the heading *Map Issues*, paper and map storage is a problem that is far bigger than is generally appreciated.

6. As the situation demanded, so deputies and assistants were provided for the Director, Map Publication. At the outset, his only assistant was the Chief Draftsman in Calcutta, in effect a publication staff officer. The increase in number of *Chief Draftsmen* has been mentioned under that heading ; and also the increase in Assistant Directors.

When the Director was moved to Dehra Dūn, a Deputy Director took charge of the offices in Calcutta. In the end, a deputy was also required in Hāthibarkala ; depending on the particular Director, administration was handled by himself or by his deputy. It was never possible to find sufficient officers to allow for two deputies, one technical and one administrative, as would have been desirable.

Because of the duplication of offices in Calcutta and Hāthibarkala and shortage of officers suitable to take charge of the various offices, some juggling had to be done with names and classification of posts.

7. Colonel O. Slater ( R.E. ) was Director, Map Publication on the outbreak of war being succeeded in April 1941 by Colonel T. M. M. Penney ( R.E. ). Lt.-Colonel G. W. Gemmell I.A. was placed on special duty and later became Deputy Director, Map Publication when map demands began seriously to expand and when the Hāthibarkala project began to develop. Colonel Gemmell succeeded Colonel Penney as Director, Map Publication in 1944 and remained as Director up to and after 1946. Colonel Gemmell held the fort in Calcutta while Colonel Penney was organizing the building of Hāthibarkala but soon after was transferred to the new office and was instrumental in organizing its plant and its personnel, first as Deputy, then as Director. When towards the end of the war forward planning to make the best use of resources took on very heavy weight, Colonel Gemmell was appointed Director of Planning ( Maps ). See *Map Publication*, 13.

#### MAP RECORD AND ISSUE OFFICE ( M.R.I.O. )

Controlled by the Director, Map Publication, the M.R.I.O. occupied a considerable amount of space in the headquarter offices

at Calcutta where it had a large but airless and ill lighted storage room jammed up with steel map racks as well as the necessary offices for maintenance of registers and the like. There was also a small map sales office.

The office was under the orders of a Class I officer of the Survey of India, who was, in effect, our Map Curator.

2. Before the war, map issues were usually in small quantities of large numbers of different sheets and the office was so organized ; as the war developed and large numbers of copies of a single sheet were demanded, storage space became inadequate. Other storage had to be acquired in Calcutta.

With the building of the new map publication offices at Hāthibarkala ( Dehra Dūn ), however, and the establishment of military map depots, this situation altered and with the transfer of our main map holdings from Calcutta to Hāthibarkala, space became available in the M.R.I.O. office in Calcutta and was used for military map storage and handling.

3. When map issues became heavy a post of Map Curator was created at Calcutta in addition to the post of O.C., M.R.I.O. As Hāthibarkala expanded and took over the main map distribution duties in its new M.R.I.O., the post of Map Curator was up-graded to Chief Curator and transferred to Hāthibarkala, the old post of O.C., M.R.I.O. being retained in Calcutta with, however, other administrative duties attached to it.

See *Map Publication Circle* and *Hāthibarkala*.

## MAP RESPONSIBILITIES

Before the war, the Survey of India was responsible for certain map series covering Burma on the east and Afghānistān, Irān and 'Irāq on the west besides its own series.

As the scope of the war widened, larger responsibilities were assumed, to cover Siam and Indo-China and Malaya and Netherlands East Indies ; we also agreed to act as a back-stop for any task that might get beyond the reach of Mid-east, whether through enemy action or through their organization being overwhelmed with work.

On the other hand, as more troops came to the Eastern theatre and more and more military map publication units were formed, our responsibilities diminished ( though our publication increased ) for these organizations took over from us the publication of operational and short-term maps, the Survey of India directing its energies to building up long-term map stocks, mostly on the smaller scales.

These points are dealt with under the various appropriate headings.

## MAP SALES

Standard Survey of India maps were priced very roughly in proportion to publication costs and with a view to recovering those costs ; they had, however, to be somewhat arbitrary because many



other factors affected overall costs of the publication offices that could not be foreseen in fixing map prices nor could prices be altered every little while. No account was taken of the major cost, surveys, in fixing map prices surveys being regarded as a public service.

Standard maps were sold to the armed forces at half list price. Special maps produced for them were charged for at cost plus 5%, cost being calculated for both drawing and publication work.

2. At the outset of the war, the procedure outlined above continued to be followed. It soon became evident, however, that it would be quite impossible for the Survey of India to cost all the special drawing and publication work done for the army; we had not the staff to do so, nor could we keep track of the fluctuating cost of paper, chemicals, etc. In many cases materials were supplied from army sources mixed with civil sources and bills, if any, came many months after the maps had been published, issued and forgotten. In the latter part of the war, much plant and machinery was supplied from army sources, not billed for, and we had no idea of prices or what the post-war procedure for adjusting debts would be.

Furthermore, sometimes maps were sent at our expense by post, freight or lorry; sometimes army lorries were sent to fetch them; sometimes they were sent by rail on military credit note. As in other branches of the services, costing became impossible.

3. On the other hand, it was not possible to treat the Survey of India purely as a "service department" in respect of maps without completely reorganizing our budget and financial procedure; and it was desirable from the army point of view to exercise some restraint on the volume of demands for maps, which could best be done by continuing the payment system.

It was therefore decided early in the war to continue the peace time system as regards standard maps supplied from Survey of India stock but to "flat-rate" all maps produced to special order by the army, irrespective of size, colours, scale, quantities of each sheet, and how delivered to the indenter. By this means, all knew where they stood financially and the Survey of India was able to budget to cover the cost of materials, plant, etc., necessary to produce any number of maps estimated by the army to be required during any financial year.

At the outset, Annas 8 per map was charged; this was clearly producing too much revenue as volume of demands increased and the flat-rate price was reduced to Annas 6, which was retained till the end of the war.

4. The rate was decided annually by the Government of India on recommendations by the Surveyor General after a review of the previous year's transactions and the estimated transactions during the next year. Though volume increased in the latter years, so did costs and the rate consequently remained at Annas 6 per map.

About the end of the war, the whole question was reviewed to ascertain whether the Survey of India had been making a profit at

the expense of the British Government, who had supplied much of the plant and material used in making the maps. The result led us to believe that the rate of Annas 6 was very close to correct, but final results could not be worked out until the method of dealing with plant, etc., after the war had been decided, not decided up to 1946. See *Information and Broadcasting*. Nor did we, by 1946, know the exact value of the plant supplied.

5. Because we were charging for maps, the whole cost of the B.O.R. Cadre of technicians and also the Officers' Cadre was paid by the Survey of India. See *Cadres*. This was billed for by the military accounts authorities from time to time. Bills for maps were submitted quarterly to the army by the Survey of India. All such transactions were book transactions except that cash could, if desired, be paid for maps out of stock. See *Green Demands, Map Publication*, 10.

## MAP SCALES

Mention of scales has been made under the heading *Map Policy* and in Chapter III. Survey of India standard topographical map scales were inch scale, 1-inch,  $\frac{1}{2}$ -inch and  $\frac{1}{4}$ -inch; except for Cantonment maps and some guide and similar maps, other maps including geographical were on natural scales.

Maps specially produced for the army were on any scale demanded by them.

2. Very important factors not always appreciated in considering map scale policy are the size of printing machines and ancillary equipment and the size of storage racks, etc. To change, for instance, from 1-inch scale to 1/50,000 scale may involve a large amount of re-machining, rebuilding of storage racks, re-glassing and re-zincing as well as a complete change in paper sizes, paper usually being ordered in large sizes so as to cut economically (with the grain the right way round) for the different maps in vogue.

To change from one scale to another is not a matter to be considered lightly. For this reason, few changes were made during the war.

## MAP SERIES

Map series are discussed under the heading *Map Policy* and other relevant headings such as *HIND Maps* and *Aeronautical Charts*. See also Chapter III.

2. Standard Indian series, which also covered Burma and in the case of  $\frac{1}{4}$ -inch and smaller scales, 'Irāq, Irān and Afghānistān, were the 1-inch,  $\frac{1}{2}$ -inch and  $\frac{1}{4}$ -inch topographical and the 1/1,000,000 and 1/2,000,000 geographical series.

A 1/500,000 series was introduced for military purposes covering parts of India and Burma and various series were published on

$\frac{1}{4}$ -inch and similar scales to cover Malaya, Siam and Indo-China. Maps of N.E.I. on various scales were also published and some of Ceylon, though that country did most of its own map publication and also helped India out. See *Ceylon*.

A civil aviation series was to be included in India's post-war responsibilities on 1/M scale, possibly on other scales.

In 'Irāq, 1/50,000 and 1/25,000 as well as 1/100,000 series were established by Paiforce, Survey of India militarized units carrying out a considerable proportion of the work up to 1943.

Some map styles are illustrated in the pocket at the end of this book.

## MAP STOCKS

Normal civil stocks were practically exhausted during the war owing to preoccupation with military map supplies and heavy demands by the army even in non-operational areas of India, for training, etc. Their rebuilding was a major factor in post-war publication programmes, heavily in demand as they became for reconstruction projects.

It was decided that the  $\frac{1}{4}$ -inch series should be re-established first as being the best all round utility scale, larger scales being re-established for special areas as demanded by geological, irrigation, administrative and other authorities.

2. Heavy stocks of maps were not held for the army after the first few months of the war. See *Map Record and Issue Office* and *Central Map Depot*, and *Map Issues*.

## MAP SUPPLY SECTIONS

These were military units for which the war establishment was approved early in the war. Hitherto, there had been no field distribution units as such.

A considerable number of these units were formed wholly or partly from Survey of India personnel during the war, whose business was to distribute maps to the troops in whose area they were working. Small units, they required little living accommodation but did require considerable space for map storage, sorting and bundling. The considerable amount of work space required by technical units is not always appreciated by lay authorities responsible for its allotment.

The original unit strength was 1 officer, 6 map storekeepers and 14 map khalāsīs, with 2 bicycles, 1 motor cycle and 2 15-cwt. trucks. This was slightly varied from time to time, but on the whole worked satisfactorily. The chain of map supply is illustrated under *Map Issues*.

In 1945 there were seven Indian Map Supply Sections, see Table D,

**MATHEMATICAL INSTRUMENT OFFICE (M.I.O.)**

The M.I.O. was formed in the very early days of the Survey of India to deal with repairs and adjustments to its instruments and gradually extended its activities to include the procurement and supply of the majority of instruments and equipment used by the Department as well as many surveying, mathematical and other instruments used by other departments, central and provincial. A large variety of instruments were manufactured in the M.I.O. and by 1939 the manufacture of binoculars had just been commenced on a small scale, army type prismatic compasses were being put in hand and plans for making our own simple theodolites and levels were under discussion.

The office and factory were in Calcutta, under the administrative control of the Director, Map Publication.

2. The army had been a big customer of the M.I.O. until 1937 when a change of policy to import from abroad was made, including importation of spare parts to be stocked at various arsenals for repairs. This policy broke down during the war and the M.I.O. was soon overwhelmed with demands for certain instruments required by the army that it was in a position to manufacture, such as binoculars, compasses, certain gun sights, stereoscopes drawing instruments and the like.

Concurrently, there were very heavy demands by the Survey of India, busy forming and equipping military survey units. There were also heavy demands by the Military Engineering Service and the Public Works Departments in connection with surveys for airfields, new factories, etc.

3. During 1940, the M.I.O. was reoriented to try to cope with essential demands as outlined in the preceding paragraph but it was evident that it was not the function of the Survey of India to control and administer it in its new rôle, nor could it do so busy as it was with its own expansion in purely surveying and map publication functions.

The M.I.O. was therefore transferred temporarily to the control of the Department of Supply (Munitions Branch) in May 1941. Since the Survey of India was wholly dependent on the M.I.O. for most of its instruments and had no other source of supply, certain safeguards were incorporated in the transfer agreement.

Details of the work done by the M.I.O. up to March 1941 will be found in the Survey of India General Reports for 1940 and 1941.

4. The M.I.O. in Calcutta continued to operate under the Department of Supply on somewhat similar lines to its traditional Survey of India functions but farming to the trade of the simpler instruments was introduced, the M.I.O. itself dealing with "pilot models" and with inspection, essential to the Survey of India for only the M.I.O. officers had the necessary knowledge and experience to ensure that instruments supplied to us were up to the requisite standards of accuracy.

A separate aircraft instrument repair organization was built up in Calcutta under the control of Mr. R. C. Malcolm, Superintendent of the M.I.O. and he was instrumental in the design of a large new factory set up by the Supply Department in Dehra Dūn, concentrating on mass production of certain instruments required by the army. Mr. J. W. Messinger, who operated this factory, gave us a great deal of help in testing and repairing instruments used in our Dehra Dūn offices.

5. By the end of the war, the situation had much altered in that the Survey of India now had a large stores organization of its own ( see *Stores Organization* ), the M.I.O. in Calcutta continued to be available to it, in common with other Government departments, and the new factory in Dehra Dūn was always ready to assist with advice or emergency repairs, etc.

In consultation with Sir Thomas F. Borwick, C.I.E., D.S.O., I.O.S., D.G. Munitions production and Mr. A. Lacamp late of the Survey of India, now Superintendent M.I.O. under the Department of Supply, it was agreed that the M.I.O. should be permanently transferred to the Department of Supply and that the Survey of India should set up a small repair organization of its own in Dehra Dūn, under the control of the Director, Geodetic Branch ; this was approved by the Government of India and the transfer made in 1946. See also Chapters VI, 73, VIII, 119 and X, 159.

6. The untimely death in 1944 of Mr. R. C. Malcolm, Superintendent of the M.I.O. for some years before the war and throughout the war till his death, was a very great loss to the Survey of India and the Supply Department, as to all instrument users ; it was very largely due to his vision, knowledge and unflagging energy that the Mathematical Instrument Office was able to take hold as it did of the war problems confronting it and expand as it did into a very big manufacturing and repair organization of precision instruments.

The Survey of India also owes much to Sir Thomas Borwick and to Messrs. Lacamp and Messinger for their continued help and advice.

## MESH

See *Grids* and Chapter III, 32-34.

## MID-EAST

Conferences with survey representatives of Mid-east were held in Cairo in 1940 and Delhi in 1941 and 1942 during which policies were co-ordinated and arrangements made for mutual co-operation in emergency. The experience gained by Mid-east before India was heavily involved in the war was of the utmost value to us particularly in respect of the huge quantities of maps required for modern war and it was due to this experience and the advice and help given by Mid-east that sufficient machinery and stores were available by 1943 when the really heavy map publication work commenced in India.

Throughout the war, map originals either on paper (*Black Print Originals*) or on film were exchanged between Mid-east and India so that either could print identical maps for the other, in emergency ; representative map designs suitable for various types of country and warfare were also exchanged.

India was a major source of supply of map printing paper for Mid-east as soon as "S.C. Ahmedābādi" paper had been fully tried out and was in full production, see *Paper*. In the later part of the war, Mid-east greatly augmented our stores reserves by transfer from them, see *Stores Organization*.

2. Indian Military Survey units sent to 'Irāq came under Mid-east orders ( and Tenth Army Paiforce ) and a number of Survey of India officers were employed in commanding, forming and training various non-Indian units or personnel.

Survey work carried out in 'Irāq/Irān has been mentioned under the heading '*Irāq*'.

The senior Survey of India officer in Mid-east was Colonel G. F. Heaney, C.B.E., later Brigadier and Director of Survey ALFSEA and now Surveyor General of India.

## MILITARY CIRCLE

The circumstances leading up to the creation of the Military Circle of the Survey of India are outlined under the headings *Frontier Circle* and *Military Organization*. With its formation, the Military Circle superseded the Frontier Circle in dealing with military matters, except training and certain works for Northern Command ( N.W. Army ).

The Military Circle was formed in 1941-42 more or less concurrently with the formation of the *Geographical Section, General Staff* and its Director, Colonel ( later Brigadier ) E. A. Glennie, C.I.E., D.S.O., was also Director of Survey ( India ) and head of the G.S.G.S.

2. The Military Circle continued to function in the offices of the Frontier Circle ( military wing ) that had been established in Delhi in 1941 and took over its clerical, etc., personnel ; it remained in these offices, close beside those of the Surveyor General in hutments attached to the Temporary Secretariat in Old Delhi, throughout the war. The ( military ) Central Map Depot was also close by and the offices of the Director of Survey ( India ) were about 4 miles away, in New Delhi ( see *G.S.G.S.* ).

The Military Circle controlled the civil side of the Survey Depot at Dehra Dūn and the Stores organization, also at Dehra Dūn. In his capacity as Director of Survey, the Director, Military Circle also controlled the ( military ) Survey Depot, the Central Map Depot, the G.S.G.S. and ( technically ) such military survey units as were serving in the India Command.

3. The major portion of the Circle's work was to do with personnel and stores ; though the details of stores themselves were

dealt with by the G.S.G.S., the financial side and the organization as such, being civil, was under Military Circle control. On the personnel side, there were always many problems to do with pay, promotion, leave, etc., and the annual increment and promotion rolls in themselves, for all the hundreds of men in military employ, were a very big task. See *Promotions*.

Though military map, etc., policy was framed by the Director, his G.S.G.S. provided his staff for this purpose; the Military Circle did not deal with the technical side of the military survey work. It did, however, deal with matters like war establishments, terms of service, etc., to which there were frequent amendments.

Practically speaking, it provided the administrative staff and office for the Director of Survey (India).

4. The Military Circle also provided a sort of military office for the Surveyor General. He relied entirely on Military Circle records for his information about Survey of India personnel in military service and for information about what non-Survey of India personnel might be expected to enter the Department after the war.

For most of the war the Assistant Director of the Circles (administrative staff officer to the D. Svy.) was Colonel R. H. Phillimore, C.I.E., D.S.O., a retired officer of the Royal Engineers and Survey of India who had spent more than a year early in the war as M.I. 4(b) in Army Headquarters. His wide military and civil Survey of India experience, as well as his recent army experience was of the very greatest value to the survey services, military and civil; his card index recording every detail of information that could be obtained about personnel in the military units was of the utmost value in deciding on promotions and rates of pay and on whom to accept for post-war employment in the Department. See *Documents*.

5. Demobilization was organized by the Military Circle, though actually carried out by the Survey Depot, in consultation with the appropriate military authorities and with the Surveyor General.

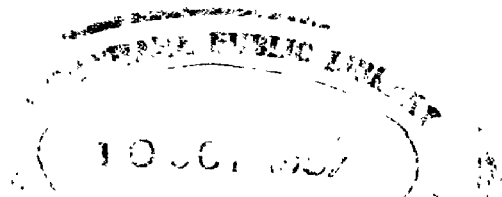
Further details about the work the Circle had to undertake are indicated under headings like *Pay*, *Promotions*, *Terms of Service*, *Survey Depot*, etc.

## MILITARY EXERCISES

See Chapter I, *Frontier Circle*, "E" Company.

## MILITARY ORGANIZATION

Before the 1914-18 war there was no military survey organization, as such, in India. During that war, the military survey strength of the Survey of India was much dissipated at the outset by wholesale transfers of its Class I military officers to non-survey military duties, many of them being killed or retained permanently





in non-survey posts ; a considerable number of its Class II ( then "Provincial" ) officers too, who had been in Volunteer Corps or on the Indian Army Reserve of Officers, were called up to serve in non-survey military units.

It was not till about 1916-17 that the campaign in Mesopotamia showed up the very great importance of having survey personnel, in organized units, with military forces in the field above all in ( like Mesopotamia ) practically unmapped country. As many officers as could be found were hastily recalled to survey duties and civil units, wearing uniform but having only "relative" military rank, were raised and despatched to Mesopotamia with headquarters in Baghdād to set about the triangulation and detail survey of that country. Later, parties and detachments were also sent to various parts of Persia and eventually to Afghānistān ( 1920 ).

In 1916, a Field Service Manual was published, detailing the pay, relative ranks and approximate establishments of Survey of India units to be employed on military survey works and outlining their duties.

The Surveyor General's Office acted as the Survey Depot for these units, maintained records, etc., and generally functioned as the base organization.

2. Much consideration was given to the problem immediately after the 1914-18 war and in 1925 a new Survey of India circle, the Frontier Circle, was formed with headquarters at Simla along with a drawing office there ( No. 6 D.O. ), two topographical-cum-military training units Nos. "A" and "E" Companies with headquarters at Murree and Quetta respectively and No. 18 ( Air Survey Party ) with headquarters at Murree but functioning in the winter at Peshāwar, later Risālpur.

This circle was required to look after the topographical surveys of the N.W. Frontier and Baluchistān and some of the Punjab, Sind and Rājputāna, and also to carry out close liaison with Army Headquarters, Northern and Western Commands and the R.A.F., to carry out appropriate military survey training, prepare war establishments and equipment tables and terms of service for Survey of India personnel to be militarized into these combatant units ; and to function as the military circle of the Department, advising and acting for the Surveyor General as necessary in military affairs.

The Frontier Circle was financed like other circles of the Survey of India, but the army paid a subvention to the Department in return for which the Department undertook to keep the Frontier Circle functioning in its semi-military capacity and also to provide ( fully equipped as regards surveying instruments and equipment ) two Field Survey Companies, two Headquarters and one Survey Depot. The maintenance of these units in war, and any other units that might be required to be raised, were to be financed by the army.

3. In 1939 there was no dissipation of Survey strength, as in 1914 and the first units required in the 1939-45 war were raised under the organization outlined above. See *Military Survey Units*. The Frontier Circle had done a great deal of mapping of trans-frontier areas in co-operation with the R.A.F. and a good deal of military training; it maintained lists of volunteers for active service (from which the first units were formed) and it advised Army Headquarters (M.I.) about Map policy and helped them obtain and stock maps. In 1940, the Director, Frontier Circle was made *ex officio* Director of Survey (India).

Details about the pre-war training and mapping and the events of the early stages of the war will be found under headings *Frontier Circle* and *Burma*.

4. Though by 1941 the Frontier Circle was in effect functioning in two wings, military and civil, it became evident with the heavy increase and spread in scope of war commitments that while a strong survey organization must remain on the N.W. Frontier to meet the requirements of Northern Command and training, a special circle must be formed in addition to organize the general military picture as it applied to the Survey of India and to attend to the many administrative tasks that arose out of the increasing transfers of Survey of India personnel to military survey units, the necessity for recasting war establishments, etc., and to organize map publication activities in liaison with Army Headquarters on the one hand and the Director of Map Publication, then in Calcutta, on the other.

The *Military Circle* with headquarters in Delhi was therefore formed, about which there is more detail under that heading.

The Director took over the *ex officio* duties of Director of Survey (India).

5. The Director of Survey (India) was thus relieved of all the training duties that he had hitherto had, as well as all responsibility for civil works and works required by Northern Command; he was now free to concentrate entirely on the organization and administration required to get military survey units formed and to maintain them, and to organize map publication as required by G.H.Q. (India) in consultation with the Director, Map Publication. So as to reduce delays to a minimum and avoid double work, he was authorized by the Surveyor General to issue orders for map publication and to decide priorities on the latter's behalf. He was given the old Frontier Circle office staff, accustomed to military regulations and to dealing with military matters, and was also given suitable assistants from our Class I military cadre.

6. Though this new organization was a great improvement on the old, it was still not enough as commitments still further increased in 1942 and it was decided that a *Geographical Section, General Staff* (a purely military organization not hitherto used in India) must be formed, which was done by the middle of that year and

was fully functioning by the end of the year, the *ex officio* Director of Survey ( India ) now becoming officially its head.

With its formation, the question arose to what extent the Survey of India should still be involved in matters more or less purely military. It was obvious that, what with organizing the supply of personnel for military units, carrying out all their training, looking after their service rights and carrying out a great deal of military survey and mapping work in its various units and offices, the Department would still have to retain its Military Circle to organize those functions and advise the Surveyor General on military matters. It was also obvious that the purely military organization would have to have some administrative set-up, unless the Survey of India did its administration for it. Both ways, to separate completely meant duplication to a considerable extent and the provision of more officers and other staff than we could find without falling down on promised military commitments.

7. There was some controversy on this point, but it was eventually decided that the Director, Military Circle should function in a dual role ; as such, under the orders of the Surveyor General ; as Director of Survey ( India ) under the orders of the C.G.S. ( *Military Operations Branch* ).

The Surveyor General of India had no direct concern with the G.S.G.S. as such ; indirectly he had, for the Commander-in-Chief in India was a member of the Government of India and the Surveyor General was survey adviser to that Government.

8. Under this dual system there were undoubtedly some disadvantages but there were also advantages. Practically no change in procedure occurred with the formation of the Geographical Section, General Staff and hence minimum upheaval ; this section dealt with the technical and operational side of the picture while the Military Circle continued to deal with the administrative and organizational side. The Survey Depot continued to function also in a dual capacity in looking after the interests of all survey service men from both military and civil sides and maintaining both military and civil records and documents. See *Survey Depot, Military Circle*.

In sum, resources were pooled.

9. This system worked satisfactorily for the remainder of the war with only minor changes in its organization. The Military Circle offices remained alongside those of the Surveyor General in Old Delhi, the G.S.G.S. offices being in the Imperial Record Building about a mile from G.H.Q. in New Delhi. See *G.S.G.S. and Military Circle*.

The Frontier Circle continued to carry out all field and air survey training and, until very near the end of the war when a map representative was installed, all work for N.W. Army ( Northern Command ) including map supply and storage. See *Frontier Circle, Training and Training Parties*.

The *Survey Depot* continued to deal with the records of both soldiers and civilians of the Survey of India and the *Stores Organization*, under the control of the Director, Military Circle, supplied survey stores to both military and civil units, civil financial powers being pooled with military priority powers in obtaining survey stores and the G.S.G.S. means of direct communication with the War Office, who authorized or supplied most of our imported stores.

As regards map publication procedure, see *Green Demands*, *Fair Drawing* and *Map Publication*.

For air surveys, see *Air Survey Party*, *Air Survey Directorate* and *Indian Air Survey and Transport*.

## MILITARY SURVEY UNITS

The Survey of India had originally undertaken to provide two Field Survey Headquarters, two Companies and a Survey Depot, mentioned in more detail under *Military Organization* and *Frontier Circle*.

2. War establishments had been prepared to meet conditions on the N.W. Frontier of India. When in 1940 it was agreed that India should be responsible for forming a total of seven H.Q. six Companies, two Map Supply Sections and three Survey Park Sections, for service anywhere required, war establishments had to be modified and new ones worked out for the Map Supply and Park sections, not hitherto envisaged ; and at the same time a Drawing section was worked out. Transport allotted was in line with that given to other technical units, with provision for carrying rotary printing machines and ancillary equipment on M.T. and for map deliveries.

Later on, other types of units were raised and war establishments for existing units modified, particularly in respect of headquarters which were made more of a staff and directing type, as in the British Army ; Indian H.Q. had been designed more as technical units. See Table D.

3. The *Survey Depot*, described in more detail under that heading, was formed at Risālpur and later transferred to Dehra Dūn.

The first units formed ( for 'Irāq ) were Nos. 1, 2 and 4 Indian Field Survey H.Q. and Nos. 1, 2 and 4 Indian Field Survey Companies ; these were all formed in Risālpur wholly from Survey of India personnel except for a very few such as the Adj't/Q.M. : by the middle of 1941 No. 1 H.Q. and Company had gone to 'Irāq, and the remainder as well as a D.D. Surveys headquarters unit followed them to 'Irāq in the early autumn of 1941. Each of these companies contained a map reproduction section with one mobile rotary printing machine.

A Map Supply Section, a Drawing Section and a Park Section followed soon after.

4. Early in 1942, No. 6 H.Q. and Comapny were raised in Burma from Survey of India personnel ; a Map Supply Section, formed in India, was also supplied. The latter was captured by the Japs ; the former units were reformed at Rānchi during 1942 after evacuation from Burma. There are more details under *Burma* and *Burma Survey Party*.

By the middle of 1942, No. 3 H.Q. and No. 3 Company were formed in nucleus in Risālpur, the full units being under formation.

About the same time, the necessity for special air survey companies ( as opposed to field companies ) became apparent and Nos. 5 and 7 Indian Air Survey Companies were formed at Mussoorie, and Risālpur respectively. See *Air Survey Directorate*. In 1944, these units were transferred to the technical control of the Director of Survey, 11th Army Group and moved to Harihar in the Southern Command.

5. With the formation of the *Geographical Section, General Staff* and the *Military Circle* in 1942, responsibility for the actual formation of units passed to the Director of Survey ( India ), the Survey of India, however, remaining responsible for the training of the majority of personnel and supply of a considerable proportion both to form new units and to maintain older ones.

The total units in existence in 1945 is shown in Table D. Not all of these were Indian units but the great majority were, and by no means all personnel were Survey of India. The Department had, however, 721 technical Officers, Indian Officers and Havildars serving in these various headquarters and units, besides a considerable number of I.O.R.'s ( this figure includes 296 soldier surveyors who though not actually members of the Survey of India were trained by it though recruited by the army ; recruitment of surveyors by the Survey of India was discontinued during the war. See *Soldier Surveyors* ).

6. Nearly all the Indian units returned from 'Irāq/Irān during 1943. Thereafter they served in eastern and southern India, Burma, Malaya, Siam, N.E.I. and Indo-China ; Survey of India personnel were represented in all these countries as well as in Ceylon.

The work done by these units was very diverse. In 'Irāq and Irān there was much ground survey, mentioned under the heading '*Irāq*' ; after 1943, the accent was more on air surveys, though there was ground survey of different kinds throughout and surveys for airfields, military bases and the like increased in the latter part of the war ; map publication work greatly increased and with it, map distribution work. It is not possible to indicate in outline the multitude of tasks undertaken by the seven main units ( Nos. 1-7 Companies ) and the headquarters that controlled them, or of the many smaller units listed in Table D but for those interested, details will be found about the employment of all military survey units during the war in the official histories being published by the War Office, London.

7. Speaking generally, units were demobilized piecemeal. Up to August, 1946, Nos. 5 and 6 Companies had been demobilized in full and No. 3 Company had been transferred to the control of D. Svy. ( India ) soon after the cessation of hostilities for work on the big Dāmodar Valley project of the Government of India where it did excellent work; this company was eventually retained as a military survey unit under the post-war reorganization of the military survey services. See *Demobilization, Projects*, and Chapters XI and XII.

## MILITARY TRAINING

Pre-war military training has been mentioned under *Frontier Circle* and “*E*” *Company*.

Apart from some training for post-war reorganization tasks, all training during the war was designed to meet war requirements, and is discussed under *Training*.

## MINIATURE PLANE-TABLING

See *Training, Plane-tabling*.

## MOBILIZATION

Mobilization schemes had been prepared for raising the units guaranteed before the war for service on the N.W. Frontier; these followed normal military practice in working to a time-table and were drawn up in the standard form.

In the event, they were little used except to provide an index of jobs that had to be done, for we mobilized to no fast time plan; in effect, we were mobilizing the Survey of India as a whole for war and the raising of military units was merely incidental to the over-all plan.

There was no mobilization scheme for the Department as a whole—it is very doubtful if one would have been of use for no one had ever envisaged that the Survey of India would turn practically its whole effort into war work and double in size while doing so. See *Military Organization, Military Survey Units*.

2. The term “mobilization” is in fact a misnomer. In the case of the military units, raising and mobilization were carried out more or less concurrently; in the case of the civil Department, organization for war was what took place.

## MONOTYPE MACHINE

This type setting and casting machine was acquired about the start of the war and was most valuable throughout. Apart from its use in letter press work ( *Letter Press Printing* ), it was practically impossible to obtain type founts on which we had to rely mainly

for names, etc., on maps ; this machine enabled us to cast our own. See *Type*.

A second machine was on order when the war ended.

## MOSAIC

“Mosaicing” is used extensively in all mapping work to assemble various field surveys or map compilations within the prescribed bounding lines of the map to be published, before re-drawing or photography. Mosaics of air photographs are of course well known to everyone. Distortions due to ground relief, lens and paper aberrations, tilt, etc., make them unreliable as a *map* but carefully used they can be most valuable for certain purposes and were so used in connection with computing the volume of water that would be impounded by projected dams during the post-war reconstruction period. See *Projects* and also *Fair-drawing and Compiled Maps*.

## MOTOR TRANSPORT

None was held for military units to be raised and almost none existed in the Survey of India at the start of the war but was much expanded during and immediately after the war. See *Transport*.

## MUSĀVI

A *musāvi* is a map sheet of a village or similar cadastral map series.

## NATIONAL PHYSICAL LABORATORY (INDIA)

The proposed formation of a N.P.L. in India is mentioned under the heading *War Research Institute*.

## NETHERLANDS EAST INDIES ( N.E.I. )

An officer of the Survey of India ( Major Wright ) visited N.E.I. during 1940 on a liaison tour to Malaya and ascertained from the Dutch authorities, who were very helpful, what maps might be available and what resources. In 1941 Lt. Colonel Gemmell was for some weeks on special duty in Singapore and extended our knowledge of the N.E.I. map situation.

When the S.W. Pacific Command was formed after the fall of Singapore, a Survey of India Officer, Colonel G. Bomford, was appointed Deputy Director of Survey for that Command.

2. In the latter part of the war, certain of the N.E.I. excellent maps were republished by the Survey of India on demand from the Director of Survey ( India ). Otherwise the Department had no contact with that country ; a few of its personnel, however, served there in military units after the Allied reoccupation.



## NORTH-WEST ARMY

This army replaced Northern Command (India) early in the war, headquarters remaining at Rāwalpindi throughout the war. This was the one army in the Eastern Theatre that had no military survey troops, all work for it being done by the Frontier Circle of the Survey of India, including map publication from about 1942 onwards. Before then, publication was carried out at Dehra Dūn and Calcutta as well as in Frontier Circle.

A Command Survey Directorate was formed in 1945 however with an Assistant Director of Survey in charge, to filter demands for surveys and maps.

Until the formation of the Military Directorate and G.S.G.S., units were raised under the orders of the Director, Frontier Circle (later Military Circle) of the Survey of India who was responsible for supplying personnel and technical equipment and stores; a few personnel came from army sources, looked after by the Survey Depot; once units had been formed, they came under the orders of the local military Area Commander.

In the case of later units, personnel was "militarized" into the Survey Depot and thence transferred to the units under formation (similarly for reinforcements); the reverse procedure was followed for "civilization". There is more detail under *Survey Depot*. See also *Military Circle* and *Geographical Section, General Staff*.

## "NOT TO BE PUBLISHED" (N.T.B.P.)

This term was introduced in Britain and followed in Burma to indicate what had previously been called "For Official Use Only" maps; India continued to use the latter term until superseded by the generally adopted term "Restricted". See *For Official Use Only*.

## OFFICERS

The Survey of India included both military and civil officers on its peace time strength and during the war special cadres of military officers (B.O.'s and I.C.O.'s) were attached to it.

Some details about the various cadres and services will be found under *Cadres, Class I (etc.) Service, Terms of Service and Organization*.

2. Under the headings *Afghānistān, China* and *Malaya* there is mention of officers from those countries who were trained by the Survey of India, as well as under *Training*. A large number of emergency commissioned officers, both British and Indian, were given training in the Department and were posted to Indian Survey units.

Civilian Survey of India officers in military employ were granted emergency commissions in the Corps of Indian Engineers, in one case in the Royal Engineers. See *Terms of Service* and Table B.

3. A list of the officers and men of the Survey of India who were employed in the army during the war is given in Table E, and a list of honours granted in Table F.

## OFFICERS' CADRE

There were various cadres, permanent and temporary, and these are described under *Cadres* and in Table A.

## OFFICERS' TRAINING PARTY

A special officers' training party ( No. 4 ) was formed and also a similar party ( No. 2 ) for training surveyors ; these are both described under *Training Parties*. The *Air Survey Party* carried out air survey training for both officers and other ranks.

## OFFICES

The Survey of India functioned partly in its own office accommodation, partly in hired accommodation ; mention of some difficulties is made under the head *Accommodation*. There is more detail under the name of the particular office concerned.

## ORGANIZATION

Organization for war work is described under the headings *Base Organization* and *Military Organization* as well as in connection with the work of the particular circle or office concerned. The civil organization was altered from time to time to meet these requirements, but the general pattern of the Department was retained, that is, its organization into circles controlled by directors under the Surveyor General. See also *Administration*, *Projects*, *Reconstruction*, etc.

2. Regionally, India was covered on the north-west by the Frontier Circle, the north-east by the Eastern Circle and the south by the South India Party, a topographical party under control of the Geodetic Branch covering the north central portion of the sub-continent.

The Geodetic Branch was responsible for scientific work, Cantonment work and forest maps over the whole of India, the Map Publication Circle for publication over the whole of India, assisted, however, by the Photo-Zinco Office of the Geodetic Branch.

The Surveyor General's Office was responsible for headquarters administration, each of the circles administering its own personnel, under the direction and general control of the Surveyor General.

On its formation, the Military Circle became responsible for military work over the whole of India, to which, however, it delegated a part of the Frontier Circle.

3. The organization as it stood before the war and at the commencement of reconstruction is shown in Table D.

The strength of the Department is shown, as it expanded, in Table C.

Other details will be found in the first part of this book, paragraphs 8, 9, 14, 22-27, 55, 56, 94, 95, 135-137, 166-169.

## PAIFORCE

Survey units with this Mid-east force ( Persia-‘Irāq Force ) in ‘Irāq and Irān were originally supplied by the Survey of India, who sent three Field Survey Headquarters, three Field Survey Companies, one Map Supply Section, one Drawing Section and one Park Section to this theatre. Their formation and work is mentioned in some detail under *Military Survey Units* and ‘*Irāq*.

2. As more British units could be spared for this theatre from Mid-east, and the war in the east began to assume greater weight, Indian survey units were withdrawn to India and by the middle of 1943 practically all had been withdrawn.

A map drawing section, however, remained in this theatre until 1945, and also some Survey of India personnel among various units there. One party of this personnel marched back to India via Kermān and Zāhidān, carrying out the triangulation connection mentioned under *Baluchistān* and described in detail in War Research Pamphlet No. 9.

3. The Survey of India also carried out a considerable quantity of adjustment work on ‘Irāq/Irān triangulation done in the field by units under the orders of Paiforce. Part of this was done on the spot in Baghdād, part of it under the control of the War Research Institute in Dehra Dūn.

Details of the adjustment were published in War Research Pamphlet No. 9.

4. An officer of the Survey of India raised and trained a Palestinian Survey Company.

5. A detailed report on the work of survey units in Paiforce was prepared by Colonel G. F. Heaney, Deputy Director of Survey, entitled “Report of the work of Survey Service with British Troops ‘Irāq, Tenth Army and Persia-‘Irāq Force”.

## PAMPHLETS

Various pamphlets issued on special war subjects of a scientific nature are detailed under *War Research Pamphlets*.

Triangulation and Levelling data are published in "Triangulation Pamphlets" and "Levelling Pamphlets" respectively ; the former, when in Grid terms, in "Grid Pamphlets".

## PAPER

The quantities of paper required for survey and map work are very great and present a considerable storage problem, apart from the problem of map distribution and storage and the filing of original records so that they shall be quickly available yet stored safely from damage by weather, termites, etc.

The maps alone published by the Survey of India during the war represent a pile of paper about 3 miles high, weighing about 2,250 tons.

2. Paper had nearly all been imported before the war. Several kinds of drawing paper were used, for different purposes, fair originals usually being drawn on Whatman's 210 lb. double-elephant hand-made paper ( tinted pale blue ) because of its non-distorting properties and strength. Lighter weight paper was sometimes used for plane-tabling work but the 210 was the standard paper for this work also.

No paper of corresponding quality was made in India and this paper continued to be imported whenever it could be obtained. When in short supply, the best available substitute had to be used ; this resulted in untidy looking drawings ( inferior paper does not take kindly to erasures ) and in considerable distortion problems.

3. Art paper was used for certain special purposes and also bank post, both imported. These were difficult to get for some time and substitutes were unsatisfactory.

Maps had been printed generally on rag-litho paper, imported ; sometimes on bank post. Fortunately the Indian paper mills were able to develop bamboo and grass furnish papers, particularly the former, and these turned out to be most excellent map papers. They were tough, water-resistant and distorted little. We were able to use these papers ( mostly bamboo ) to the complete exclusion of imported papers for map printing ; the mills were able to produce enough not only to supply the Survey of India very large demands but also the equally large army demands and in addition enough to send many tons to the Mid-east theatre.

The skill and enterprise of the Titāgarh Paper Mills in producing this paper known as Super-calendered Ahmedābādi in such huge quantities went a long way to keeping the forces supplied with maps for the major part of the war, and their readiness to co-operate in manufacturing sizes that would cut to suit the machines in use was most gratifying and saved much time.

4. Storage and distribution is discussed under *Stores* and *Map Issues*. See also *Rations*.

## PARTIES

The basic field survey unit of the Survey of India is the Party, consisting usually of from 40 to 80 officers and technical personnel, *plus* the necessary Inferior Service personnel ( *khalāsīs* ) numbering from a dozen or so in recess to several hundreds in the field, depending on the work.

The Party is a somewhat equivalent unit to the Company in the army, but it is flexible instead of fixed in size and officer ranks.

2. The work of certain parties particularly connected with the war is outlined under appropriate headings such as *Air Survey Party*, *Cantonment Party*, *Training Parties*.

Detachments are smaller units commanded by less senior officers. These were formed to carry out the *Hazāra* and *Kulu* settlement surveys, and similar tasks.

## PAY AND ALLOWANCES

Pay and allowances of Survey of India personnel while in military employ are discussed under *Terms of Service*, and outlined in Table B. These had been fixed in 1934 but were changed immediately the war started and, as army pay changes occurred, several times thereafter.

2. The pay of Survey of India personnel in Departmental employ was complicated in that there were a number of different scales in use, some fixed by the Government of India, some by the Surveyor General; the majority, but not all, were incremental scales but the times for increment varied—some annual, some biennial, some even at longer periods. In some, rank promotion altered the scale, in others, it did not do so. In some, the periodic increment was fixed, in others, not fixed but at the discretion within limits of the competent sanctioning authority.

In the case of fixed increments, the situation was simple enough except where an efficiency bar fell; in the discretionary increments, the system demanded comprehensive increment rolls which had to be prepared with somewhat lengthy recommendations by the unit commander, sanctioned by the circle director and finally approved ( as a co-ordination measure ) by the Surveyor General.

Apart from complications arising out of enhanced war prices, the system—working admirably in peace—made for very heavy administrative work.

3. In common with all civil services of the Government of India, allowances in the Survey of India were granted on a number of different bases such as for specially unhealthy localities or specially expensive localities, for special responsibilities and of course for travelling costs which varied with the locality also; during the war, these were further complicated by certain war allowances.

Some allowances were flat-rate by ranks or length of service, some on a percentage basis, some a combination of the two; in some, marginal adjustment was legislated for, in others not.

Army allowances were different from civil, in travelling as in every other allowance; further, the army provided for trade pay which the civil did not. There was therefore a very considerable amount of administrative work not only in administering the multitude of allowances as such (with constant representations for bigger allowances as prices went up) but also in keeping the balance—and keeping the peace—between our civil personnel and military personnel that belonged to the Department or were attached to it. In some cases civil “scored”; in others, military—in every such case of men working side by side a grievance had to be sorted out.

4. Survey of India pay and allowances became very low in comparison to military as the war progressed, in particular as food prices rose and certain grains became difficult to get. The Finance Department were not unnaturally averse to granting more pay, because of inflation dangers and the difficulty of reducing pay once raised; various food subsidy schemes were introduced in the Provinces and at the Centre, all different and this too caused difficulty in an All-India Department such as ours; any excuse was good enough to resist a transfer from a good food subsidy area to one regarded as a “bad” one. Agitation to join the army became considerable also; but all could not be in the army, nor were all qualified physically or technically to meet army requirements.

In the end, the Surveyor General was successful (after many tries) in obtaining pay and allowances for the Department that fairly reasonably represented their worth and did not cause too much of a gap between civil and military total emoluments among contemporaries sitting side by side in an office or field party. There was, however, much reluctance to be demobilized among many officers and men and many dropped to less than half their army pay in doing so.

On the other hand, our British technicians, both officers and other ranks, were keen to go back to civil life where they could earn more than in the army.

The conclusion appears to be that Survey of India pay was too low, in relation to the calibre of men employed in it. I am speaking of the civilians; in the case of army officers, there was not much to choose between civil and military total emoluments in the later stages of the war though in the earlier part those in military employ were better off. See *Promotions and War Allowance* for some difficulties with temporary ranks. See also *Trade Pay*.

5. It was within the competence of the Surveyor General to grant temporary increases of pay to personnel of the Lower Subordinate and equivalent services (provided their pay had not been

fixed by Government ) and to the Inferior ( Class IV ) Service. Considerable use was made of this power to recompense surveyor-instructors and surveyors, clerks, draftsmen, etc., who were temporarily performing duties of greater responsibility than those of their rank ; many were doing so of course, because of expansion and absence of seniors on military service. In the case of posts on fixed pay, officiating promotions under normal rules met requirements.

This helped materially to keep many of the lower paid staff contented, as cost of living rose.

## PERSIA

See *Irān*.

## PERSO-BALUCH PARTY

This party was formed by the Eastern Circle and operated in co-operation with No. 3 Indian Field Survey Company in western Baluchistān and eastern Irān in carrying out triangulation and route surveys. See *Baluchistān*. It was disbanded on completion of the work.

## PHOTOGRAPHS

Though ground photographs were used for some mountain surveys in peace time, they were used almost not at all during the war, air photographs ( both vertical and oblique ), however, being used to a very great extent.

See *Air Survey*, *Indian Air Survey and Transport, Projects*, etc., also *Libraries*.

## PLANE-TABLING AND PLANE-TABLERS

The majority of Indian maps were surveyed by plane-table methods, based on triangulation or traverse control ; only on the N.W. Frontier and for some special surveys had air survey methods been used. The Survey of India therefore possessed a considerable number of plane-tablers of very high standard.

The term "surveyor" was usually applied to plane-tablers, other surveying trades being specially indicated by such terms as air surveyor, leveller, triangulator, etc. See *Surveyors*, *Soldier Surveyors*, *Lower Subordinate Service*.

2. The standard Survey of India plane-table and sight rule were large compared with the military type, and heavy ; they were the simplest and most robust type that could be devised, designed to stand rough treatment and to resist weather conditions. Telescopic alidades were not used.

Standard plane-tables were 30" × 24", sight rules 30" in length. Surveyors had, however, been taught to work with the 24" × 20" sometimes even smaller military plane-table, with 24" sight rule.



The latter types were mainly carried by military survey units though a few Survey of India patterns were also carried for larger work, giving as they do more room to plot distant points on even a fairly large map scale.

3. Though contours were sometimes actually surveyed with the clinometer ( on very large scale work or on very flat ground ) they were more usually "sketched" in with relation to numerous heights deduced from clinometer readings at resections or to intersections. Surveyors became very skilled indeed at accurately depicting ground shapes and heights by this method. This served the Survey of India units in 'Irāq in good stead, for many thousand square miles had to be surveyed against time in that country and Irān, by plane-table methods. See *'Irāq*.

Because there is no better method of teaching what a contour is and what it means on paper, all Survey of India air surveyors were required to do plane-tabling training. In fact in peace time, none but expert plane-tablers were accepted as air surveyors.

A miniature plane-tabling outfit, designed by Sir Clinton Lewis the late Surveyor General, proved of considerable use in expediting training in the Surveyor's Training Party at Abbottābād. Like the usual military sand model, it enabled country to be explained to trainees indoors before they commenced their work on the ground.

4. All officers and other ranks of the Survey of India recruited during the war for field duties and all trained by us for field duties with the survey service were required to do a course in plane-tabling and to become reasonably proficient in it; otherwise, they were transferred to office work. "Field duties" includes air survey in this connection.

This training was mostly carried out in the Abbottābād region, easy country for beginners. Those required to plane-table in jungle areas required further instruction in the specialized methods necessary for such terrain, such as "sound traversing", the use of rope chains, compass traverses and the like. See *Training*.

5. Except in India itself and in 'Irāq/Irān, no great amount of plane-tabling was done during the war, surveys being made mainly from air photographs. A considerable amount of rapid reconnaissance plane-tabling was, however, done on the Baluchistān/Irān border, see *Baluchistān*.

6. Full information about the art of plane-tabling, as practised by some of the finest plane-tablers in the world, will be found in Chapter V of the Topographical Handbook of the Survey of India.

## PLANT AND MACHINERY

Before the war, the Survey of India had a considerable variety of plant and machinery for a number of purposes but not a very great quantity of each type.

The Mathematical Instrument Office, transferred, however, to the Department of Supply in 1941, possessed numerous machines necessary for the construction of mathematical, surveying and optical instruments, including a dividing engine, lathes, etc., of various styles, lens grinding machinery and so on. During the war this was very greatly expanded, as outlined under *Mathematical Instrument Office*.

2. There was a small workshop in the Geodetic Branch compound at Dehra Dūn which possessed some metal and wood working machinery and in the various observatories were instruments and machines for the purposes for which they were designed, a tide-predicting machine, a tape standardization installation with various length standards including a quartz metre, magnetic and gravity instruments, a Shortt Clock for precision time measurements with connected apparatus, a solar telescope for sun photographs, and of course a considerable amount of corresponding precision field instruments.

In Murree and Risālpur there were also small workshops for minor instrument repairs.

3. The Air Survey Party used simple portable instruments in the main but did have a stereocomparator and a co-ordinatograph by Coradi as well as one manufactured in the Mathematical Instrument Office; three new co-ordinatographs were on order when the war started, but we were not able to obtain them up to 1946.

Heavy plant was not increased during the war, except by the installation of a Wild A 5 autograph loaned to us by the Government of Afghānistān; this is mentioned in more detail under *Afghānistān*.

4. There was little motor transport; a tractor-trailer had been purchased just before the war to mount one rotary offset machine, and negotiations for a second trailer were in progress. "E" Company possessed two old 30 cwt. lorries, near worn out.

The great expansion in motor transport during the war is described under *Transport*.

5. The bulk of our plant and machinery (excluding the M.I.O. see para 1) consisted in that required for preparing, printing and mounting maps. The location of the various map publication offices is dealt with under *Map Publication* and connected headings, as well as their reorganization and expansion.

The main part of our map publication plant and machinery was in the Photo-Litho Office and the Map Record and Issue Office in Calcutta, where there were a number of cameras (some built-in) with ancillary apparatus, a number of transfer, proving and duplicating presses, eight flatbed printing presses mostly of large size such as quad-demy and four hand-feed rotary offset machines of double-demy size of which two were shoot delivery, two chain delivery. There were also guillotines of various sizes for paper cutting and a map mounting machine, gas fired.

The Geodetic Branch Photo-Zinco Office had similar equipment to that in Calcutta, but in less quantity, and no map mounting machine, mounting being entirely by hand. There was one hand-feed rotary offset machine and one flatbed printing press.

In Risālpur/Murree was one hand-feed rotary offset machine with a small amount of ancillary equipment besides the mobilization equipment set aside for the formation of two Reproduction Sections with hand operated plant that could be packed on mules, or in the case of cameras, carried on small trucks or carts. The offset machine, which was also double-demy like those in Calcutta and Dehra Dūn was about to be mounted on the trailer mentioned in para 4.

6. The Engraving Office in Calcutta possessed the machinery necessary for copper plate engraving, including electrical copper deposit equipment. Though engraving was continued throughout the war ( see *Engraving Office* ) no new plant was added.

7. There were letter press printing sections both at Calcutta and Dehra Dūn, of which the former was closed down during the war and the latter expanded. This office had the necessary equipment for hand composing and undertaking a limited amount of printing ( including the making and printing of half-tone blocks ) and received a "Monotype" type casting and type-setting machine in 1941 shortly after the war started ; which proved invaluable to speed up war printing work and to cast type for use in applying names to maps. See *Letter Press Printing* and Table K.

Sanction was obtained to modernize this office during the war and a considerable amount of new plant was on order, including a second Monotype machine, book binding machinery and modern printing machinery.

8. It was in the map publication department, however, that major war expansions occurred. Five modern automatic high speed rotary offset machines had been ordered shortly before the war and were received in its early stages, two quad-demy and three double-demy. As map printing demands increased and eventually the new *Hāthibarkala* offices were developed and the existing Photo-Zinco Offices expanded, considerable numbers of new machines, including some 2-colour machines of both quad- and double-demy as well as demy size, were installed.

To keep these machines working necessitated the installation of a number of new proving and duplicating presses and some transfer presses, as well as a number of additional cameras, whirlers for coating plates and other plant. A new and very large map varnishing machine, electrically heated, was also installed in the new H.L.O. at *Hāthibarkala* and provision was made in these offices for diesel-electric generating plant to keep at least half the factory working in case of failure of the local hydro-electric supply.

Local electric supply being alternating current and some of our equipment being designed to operate on direct current, rotary

converters had to be installed, though as far as possible, equipment was re-motored so that all should be workable on A.C.

9. In Murree too, considerable expansion of plant occurred to the capacity of the offices. A petrol-electric plant supplied reserve power in that place and in Risālpur provision was made for utilizing either the hydro-electric A.C. power or the M.E.S. power house D.C. supply.

10. The expansion in major items of publication plant and machinery is shown in Table H. Obsolete equipment was transferred to other Government offices or sold to the trade.

11. Major fixtures were a large quantity of steel shelving for maps that had been installed in the Map Record and Issue Office in Calcutta, was ripped out from there and finally re-installed in the new M.R.I.O. in Hāthibarkala ( Dehra Dūn ). Some, but quite insufficient, wooden shelving and racking for glass negatives and zinc plates existed in all offices and this storage ( built-in ) was very greatly increased particularly in the Dehra Dūn offices and also in Murree for the storage of N.W. Frontier maps, hitherto stored in Calcutta.

Each party and office also possessed numbers of cupboards of various sizes designed to store original plane-tables, fair-drawings, etc., as well as large numbers of drawing tables, chairs, draftsmen's "stools" ( for keeping inks clear of the drawing tables ) and office furniture and equipment. The Hāthibarkala office had to be completely equipped in this respect, and other offices greatly expanded to meet war expansion in drawing, as well as negative retouching and zinc correcting.

12. The creation of the *Stores Organization* of the Survey of India, in the end occupying 13 large buildings in Dehra Dūn, involved building in a great quantity of racking and shelving as well as considerable portable furniture and the Central Map Depot under the orders of the Director of Survey ( India ) but arranged for by the Survey of India also involved built-in wooden map storage racks in two large buildings.

During the growth and transition of the Stores Organization, hired buildings were occupied and much temporary storage had to be constructed in the form of trestles, racks, etc.

When the war ended, negotiations were in progress for the requisition and installation of a roller re-covering plant. Printing machine rollers had hitherto to be sent to Britain for re-covering.

## POSTINGS

All postings had to be reported to audit and they were many, causing a good deal of administrative work, for audit registers were not designed to cope with the many and rapid changes under war conditions in a Department that was continually exchanging personnel with those in military employ or having to reshuffle its officers to meet vacancies caused by postings to military.

Postings to the Survey Depot, that is transfers from civil to military employ, were made by the Director Military Circle/Director of Survey ( India ) under the authority of the Surveyor General on the one hand and the army authorities on the other ; this he was able to do in his dual civil/military capacity. Similarly, the O.C. Survey Depot was able to deal with personnel posted to him in a dual civil/military capacity, saving much trouble in such things as travelling allowance, personal documents, leave, etc. See *Military Organization and Survey Depot*.

## POST-WAR

As early as 1943, demands began to come in for works, maps, etc., for post-war reconstruction and rehabilitation. From then onwards, post-war organization had to be considered, along with preparations and in some cases preliminary works for projects that were envisaged by the Government of India.

Various proposals and reports had to be submitted to the Government of India in connection with projects and in connection with the employment of personnel, both Survey of India and others temporarily in the army who would be jobless after the war ; reports in connection with demobilization measures, leave to be granted and so on also took much time.

2. A "Projects Circle" was created to deal with the technical end of this work, the administrative end being dealt with by the Surveyor General and the Director Military Circle ( Director of Survey ) in consultation. Post-war pay rates were worked out and jobs offered to those in military employ as the expansion of projects demands made it clear that jobs would become available. We resisted the employment in the Survey of India of men from other than survey sources because we were unlikely to have more jobs than could be filled by survey personnel and also because there would be little time for training men ; we wanted men who had already been trained and these could be found only in the military survey service. Furthermore, we wanted to ensure that the survey service, at least, would not be jobless.

3. The post-war situation is dealt with under the various appropriate headings such as *Projects, Reconstruction, Training* and in the various tables showing the pre- and post-war strengths and organization, as well as in Chapter X, 138-146 and Chapter XI.

## POWDER PROCESS

This process is widely used in the Survey of India for duplicating negatives in perfect register, particularly in connection with colour separation by the duffing method. See *Fair-Drawing and Map Publication*. It requires a humid atmosphere to work satisfactorily which was a factor in the selection of Dehra Dūn for the new Hāthibarkala map factory.

## PRE-WAR

See Chapters I-III and the various subjects concerned.

## PRINTING

Besides map printing, the Survey of India carried out a great deal of letterpress printing of technical books, pamphlets and tables during the war, as well as setting up map footnotes, etc., in type.

See *Map Publication* and *Letterpress Printing*.

## PRISONERS OF WAR

The survey service lost a Map Supply Section as prisoners of war in Burma, see *Burma* and Table G.

*Enemy Prisoners of War* were utilized in the Survey of India to a small extent, see *Projects* and *Afghānistān*, 4.

Surveys for Prisoners of War and internment camps were carried out by No. 20 (Cantonments) Party in several places.

## PROGRAMMES

Topographical surveys in peace time were to a reasonably set routine programme and cantonment surveys to a definite 5-year programme.

During the war, these had to be dropped (in particular see *Cantonment Party*) and though map preparation and publication was to a programme to fit with army timings, it had frequently to be interrupted to meet emergencies.

Towards the end of the war programmes for reconstruction surveys were being framed in accordance with the priorities laid down by the Government of India. Further topographical programmes were awaiting sanctions to post-war re-organizations both of the Department and of its survey and map policy. See *Map Policy*.

## PROJECTIONS

Survey of India topographical series were on the simple polyconic projection, geographical series on a modified secant conical except that the International Series was being drawn on a modified polyconic projection (Lallemande's).

Under *Grids* it has been mentioned that the grid projection may be different from the projection of the map itself and for grids the Survey of India used Lambert's conical orthomorphic projection. See also *Spheroids*.

For the new 1/1,000,000 international aeronautical series it was proposed to use the conical orthomorphic projection also, though the Survey of India were against this; see *Aeronautical Charts*.

2. For cantonment, cadastral and special maps, the projection selected depended on the circumstances of each case, but was usually Cassini. A notable exception was the *Hazāra* Survey.

War surveys made *de novo* were normally made on the Lambert projection.

## PROJECTS

This heading refers particularly to post-war reconstruction works some of which, however, had to be started as early as 1943 in a small way and by the end of 1944 a number of quite big works had been put in hand, mainly in connection with irrigation and "grow more food"; these were mostly short-term works to improve the food situation as quickly as possible. The loss of Burma rice was a serious matter to India, and wheat supplies to the large forces based on India were a heavy drain on its resources.

Power too was in short supply owing to the very heavy expansion of war factories, though power and flood control projects for the most part came into the post-war long term rather than the immediate short-term programme. Sir William Stampe had come to India to assist in developing resources and a number of the works undertaken were at his request; long-term projects were undertaken mainly at the request of the Chairman of the Central Waterways, Irrigation and Navigation Commission (CWINC), Rai Bahadur A. N. Khosla, I.S.E., of the Irrigation Branch of the Public Works Department, in connection with whom the Survey of India had done a considerable amount of irrigation survey work in the Punjab between 1925 and 1939.

Surveys were also undertaken for provincial Governments for development of power, flood control and irrigation mainly in the Punjab, Sind and United Provinces and later in Madras.

2. The biggest projects are dealt with in separate headings, see *Kosi*, *Tista*; and "projects" of biggish size that were executed during the currency of the war are described under the headings *Hazāra*, *Kulu* and *Gurgaon*; the last named was an irrigation project connected with "grow more food" undertaken for the Government of the Punjab, the two former were settlement surveys undertaken for political and training reasons, in the N.W. Frontier Province and Punjab respectively.

Table N outlines the various projects that had been completed or were in hand up to the middle of 1946, by which time Survey of India personnel had begun to be demobilized from the army in some quantity and army map demands upon us were beginning to fall off. The general trend of the development of the projects situation as it affected the Department is outlined in the following paragraphs, and includes some mention of surveys required by the Geological Survey of India for the development of mineral resources and for which it was hoped that annual programmes suitable alike to them, other civil interests and the army might be prepared. See also Chapter X, 138-146 and Chapter XI.

3. By early 1944 demands for surveys and ( for the moment ) non-existent maps for projects of various types, large and small, had become heavy and their proper tabulation and correspondence in connection with them was throwing a heavy burden on the Surveyor General's Office which was dealing with them in order to relieve circles already excessively busy with war work and to keep centralized records ; we could meet few of the demands at once though some of the most urgent were got into the estimate stages and a few small ones undertaken. It was evident, however, that demands were much on the increase and that special steps to cope with them would have to be taken ; this led to a special post of *Projects Officer* being created in April 1944 whose function it was to tabulate, estimate, conduct correspondence and plan for execution when personnel should become available ; the work of this office and its subsequent expansion is outlined under the heading *Projects Officer* ; as explained under *Air Survey Officer*, the two posts were at this time amalgamated.

4. Trained ground survey personnel were in very short supply, so many being in military employ ; instruments too were short and ground methods as usually used for surveys of reservoirs and the like were slow. On the other hand, our charter with Messrs. Indian Air Survey and Transport Ltd. made photographic aircraft readily available and it was evident that if we could devise photographic methods that would produce the requisite accuracy much more work could be accomplished in a much shorter time than on the ground, and much more cheaply ; furthermore, the majority of surveys demanded at this stage were for reconnaissance purposes—to decide whether or not a project was a practical proposition, what volume of water a dam of a certain height would impound and so on.

Methods adopted, that proved very successful, are outlined in the following note by Lt.-Colonel D. R. Crone, O.B.E., R.E., who devised these methods while functioning as Projects Officer and Air Survey Officer. The note was written to accompany the first report of civil activities issued ( in 1945 ) by the Survey of India during the currency of the war\*.

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\* Note by Lt.-Col. D. R. Crone, O.B.E., R.E. ( Air Survey Officer, Survey of India ) on Air Survey Methods in current use in connection with urgent reconstruction projects in India.

1. In order to cover the requirements of Irrigation engineering with the small staff available, methods have had to be adapted and new methods devised to produce the required results with the minimum skilled output.

Air photography has played a considerable part in this adaptation.

2. For the measurement of area and capacity of reservoirs the air photo mosaic has been adopted.

Although theoretically air photographs of hilly or mountainous country cannot be mosaiced with any accuracy, owing to height distortion, the actual portion of interest to the engineer is that which will be submerged at designed full capacity. Except in the very highest dams this area has relatively low relief. Accuracy can therefore be obtained by photographing from the greatest possible altitude and mosaicing carefully to secure exact fit along a contour chosen to give the minimum error of capacity. This



5. At the outset, this work proceeded slowly through lack of trained staff. As young officers, *Topographical Assistants* and others under training gradually picked up the idea of the work and gained experience speed improved and by 1945 when the demobilization of trained personnel gradually began to accelerate, we had completed or taken in hand a considerable volume of this type of work which included reservoir and irrigation systems in the Tons-Giri valley west of Dehra Dūn, the Kohtri and Nayār reservoirs in northern U.P., the Dhiāngarh and Bhākra projects in the Punjab, the Rihand reservoir in the Son valley in Bihār, the Chambal reservoir in Rājputāna and seven reservoirs of the Erinpura system in Jodhpur State.

6. In 1945, many more works were demanded, including the huge Kosi and Tista projects (outlined separately under those heads). By the end of 1945 the flow of personnel back from the army was steadily increasing and with VJ day our training commitments for the army slacked off very materially. The two training parties in Abbottābād (see *Training Parties*) were therefore converted into special parties for the devising and teaching of methods appropriate to the many big projects by then envisaged, standardizing as far as possible and using air survey methods as much as possible. At the same time, projects work was transferred to the Eastern Circle eventually to be distributed among the various regional circles in whose areas the various projects fell.

During 1946 special parties were formed at Abbottābād, from personnel trained there, to undertake the first full scale field season

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contour is normally the mid-contour of the designed working head when this has already been chosen tentatively, otherwise it is the contour two thirds or three quarters up the dam.

For laying down the mosaic the contour is selected from existing maps when the mosaic is required in a hurry otherwise it is determined roughly by the height control.

For drawing the contours, height control is required. Spirit levelled heights take much time and labour to determine and are difficult to identify on the photographs. The accuracy of capacity measurements required is normally only 5%.

Formulae have been devised which connect the area and perimeter of the reservoir and the average slope of the ground with the accuracy and spacing of the ground height control required. By these means it has been possible to obtain the required accuracy from networks of clinometer heights provided certain precautions are observed in the use of the clinometer. Elsewhere, in heavy forest, it has been possible to obtain the necessary height control by the use of Paulin barometers, again with specially designed safeguards. In this way ground control and mapping for a considerable number of projects has been brought within the scope of a very small staff.

3. For the large scale mapping of dam sites for engineering plans air survey has also been adopted and certain special methods designed. In the mountainous country of the Himālayas where the projected series of great Punjab dams lies, the conventional spirit levelling for height control is extremely extravagant of time and labour. A method of subsidiary triangulation using the Tavistock theodolite was adopted on two projects and was prosecuted with such vigour that the out-turn of spot heights per observer per day approached that of a plane-table and clinometer, but was far more accurate.

Elsewhere in precipitous and in forest country, an accurate method of correcting heights determined by parallax readings on air photographs for the tilts of the latter has been developed. This has given results to the desired accuracy of five feet in height even on bromide paper prints of country showing relief of 50% of the flying height. The method has been described in Technical Instruction No. 3 issued by Air Survey Officer, Survey of India and in outline in a pamphlet that it is hoped will be published shortly.

that would occur in the winter of 1946-47 and were despatched before that field season to their various regional circles. Meantime, the preliminary work of reconnaissance, estimating, etc., was carried on. In all cases, air survey methods were used to the utmost to save time and field personnel, for many of our men were still employed in the army.

7. Concurrently with this projects work, the air survey of a part of the Bālipāra Frontier Tract in Assam progressed slowly, being carried out mainly by Italian Co-operator Prisoners of War ; its progress was slow because of other commitments and the difficulty of obtaining photographs of the high ground in it, see *Assam* 5 ; topographical surveys for geological purposes were in hand during 1945-46 but in a small way, due to lack of personnel and to the post-war topographical programme not yet being decided. See *Map Policy*.

8. Throughout the war there had been some demand for surveys to meet geological requirements but these had mainly been of a geophysical nature. Towards its end, heavy demands for topographical surveys began to come in, for the development of coal bearing and iron ore areas in various parts of India, notably the Central India States and Punjab. These were asked for on the 2-inch, sometimes the 4-inch, scale while our normal topographical scale was 1-inch ; it therefore seemed necessary to re-consider our "standard" topographical scale, the more so that the army was becoming more and more accustomed to working on the 1/25,000 scale (about 2½ inches to a mile). It was hoped that we could arrange for co-ordination not only of scales but of areas to be surveyed each year to meet the requirements of all ; it is of course well known that as a country develops, so the scale of its maps must become larger.

Mention is made under the heading *Afghānistān* of a survey for the developement of coal that was in progress during the war.

## PROJECTS OFFICER

The necessity for the creation of this special post on 1st April 1944 is explained in the foregoing heading, *Projects*. So many demands were coming in that one authority was required to filter them, estimate, correspond with indentors and so on, who was quite free of other tasks ; at the same time, this officer had to be an air survey expert and also well versed in all survey methods as well as being familiar with types of country throughout India. This implied a senior officer and with the dissolution of the military Air Survey Directorate, Lt.-Colonel D. R. Crone, O.B.E., R.E. became available. He was appointed to this post, with the status of Director, Survey of India while continuing to carry out the functions of Air Survey Officer that he had been performing while in the Air Survey Directorate, in addition. See *Air Survey Officer*.

2. At the outset, the Projects Officer had almost no office staff, owing to shortage of personnel of all sorts ; he relied on help from the Geodetic Branch for this purpose, and was provided with an office by that already harassed Branch. Owing to technical audit difficulties, no staff could be posted to his office as such, for the Government sanction was for a Projects Officer only ; staff employed by him had to be on the books either of the Geodetic Branch or the Eastern Circle. This staff increased as the volume of projects work increased. Eventually, the post of Projects Officer was combined with that of Director, Eastern Circle and administrative difficulties then disappeared.

3. The function of the Projects Officer was to tabulate, filter, correspond and estimate ; a sufficient technical staff to assist in estimating had soon to be provided ; then a staff to execute smaller works and to assist in the preliminary planning of larger works and their transfer to regional circles ; then a circle ( the Eastern Circle ) to perform these functions on a much larger scale ; finally, the allotment of all works, large and small to the regional circles as these reverted to peace-time organization in 1946, and the abolition of the Projects Officer as such.

A post of Air Survey Officer and Projects Staff Officer was then created on the staff of the Surveyor General, to co-ordinate work between circles and to deal with requests coming to headquarters, on behalf of the S.G.

4. Some fairly large works carried out under the direct control of the Projects Officer are named in *Projects 5*.

## PROMOTIONS

No change was made in the system current in peace time in respect of promotions in the civil Survey of India ; a great many more officiating and temporary promotions of course occurred because of expansion and absence on military duty of a large number of officers and other ranks.

The military ranks to be granted to civil officers and other ranks of the Survey of India on being transferred to military duty were laid down in the *Terms of Service* ; they are discussed under that heading and detailed in Table B. Civil promotion carried with it the corresponding military promotion in such cases, provided there was a military vacancy in the higher rank ; it was known well in advance when an individual was likely to come up for civil promotion and, so far as possible, provision was made beforehand to make the military promotion follow automatically.

In the reverse case, that of a vacancy occurring in military but not in civil, acting promotions had to be made under military rules ; this sometimes caused difficulty by making upsets in civil *vis-à-vis* military seniorities but, particularly as the number of military units increased and the civil department also expanded, these were usually able to be smoothed out by suitable transfers either in

military or civil. It was regarded as very important from the point of view of morale that civil seniority should be reflected in military seniority.

2. There was considerable difficulty in the case of the military cadre of the Survey of India ; those employed on military duty received temporary promotion according to the post they held, those employed in the civil Survey of India did not. Yet about half our total military cadre had to be employed in civil at all times, to keep the civil Department functioning as the *Base Organization* in support of the military survey service.

Exchanges became very difficult ; free exchange should have been possible for most efficient working but to move an officer from military to the equivalent or even a higher post in civil entailed the loss of his temporary rank which slowed him up for war substantive rank and, in turn, for further promotion and pensionary advantage on going back to military duty. Naturally, there was reluctance to return to civil duty even though the best interests of the military service itself demanded such return. A further point that may seem unimportant but was nevertheless very bad for morale was the fact that whereas a Major who was Deputy Director of Survey in the army held the rank of Colonel, one who held the equivalent post of Director, Survey of India, continued to hold only his substantive army rank ; similarly with other ranks.

All efforts to remove this anomaly failed and there was consequently some loss of efficiency both because of natural hesitation to order an officer from a higher rank to a lower one and because of some loss of morale among officers perforce in the civil Department while their juniors were holding higher military rank in the military units.

3. The simple course, which was recommended by the Surveyor General, was to classify Survey of India posts and grant temporary rank for holding them, together with the option of whichever was better of military or civil pay ; as in fact was done in the case of those in military employ. All difficulty would have been removed at once, and exchange made easy. See also *War Allowance*.

## PUBLICATION

The publication of maps is dealt with under *Map Publication* and connected headings ; of pamphlets, tide-tables, trig. data and other letterpress work under *Letter Press Printing*.

Certain reports had been published annually in peace time but these were dropped early in the war ; see *Reports*.

## PUBLIC WORKS DEPARTMENT

The Central Public Works Department was responsible for the upkeep of Government owned offices occupied by the Survey of India and also carried out the construction of the new Risālpur and

Murree offices completed early in the war, and the large Hāthibarkala project described under the heading *Hāthibarkala*. In addition, this department carried out in Dehra Dūn a large amount of work in connection with the expansion of the Geodetic Branch offices, the building of the 13 new stores offices ( *Stores* ) and the building of barracks for the B.O.R. Cadre ( *Cadres* ).

Busy as it was with airfield work and the construction of many Government offices and factories, etc., the C.P.W.D. spared no pains to meet the requirements of the Survey of India and the military survey service ( *Central Map Depot* ) not only in building construction but also in the provision of built-in and other furniture needed, provision for water supply, electricity, etc.

The ready co-operation of the Chief Engineers, Superintending Engineers and Executive Engineers and all other ranks of this very heavily worked department of the Government of India did much to keep the Survey of India functioning efficiently during a period of great expansion.

## PULL

In printing terms “once through the machine”. See *Impression*.

## PUNJAB IRRIGATION PARTY

See *Gurgaon*.

## PYTHON

The term “Python” was a code word for the military repatriation scheme under which British Service Officers and Other Ranks were repatriated to U.K. after a specified period spent in the Eastern Theatres. It did not directly affect Survey of India personnel ( except possibly British Officers of its regular military cadre ) but it did affect attached personnel in the B.O.’s and B.O.R.’s attached cadres. See *Cadres*.

Those who desired to serve longer in the Eastern Theatres than the period prescribed by Python, were permitted to take leave in lieu and return to India or other eastern theatres after their leave. This leave was called “Leave in lieu of Python”. See *LILOP*.

## RADAR

Radar methods of fixing the position of the air camera in space, or of controlling the aircraft carrying out survey photography flights, were not used by the Survey of India up to the end of the war.

The introduction of direction finding stations in India made for some difficulty from the survey point of view in choosing map projections for aeronautical charts. See *Aeronautical Charts*.

## RANKS

Military ranks granted to civil officers on being mobilized are indicated under *Terms of Service* and further discussed under *Promotions*.

## RATIONS

Rationing that most affected the Survey of India was food, petrol and paper. Rationing of cotton and woollen goods also made for some hardship among members of the Department but this was due to no little extent because purchasers were not ready to accept anything as being better than nothing. To some extent, the same remark applies to food grains. Some car owners converted their cars to charcoal fuel and most commercial buses had to do so ; but it was never satisfactory and no Survey of India vehicles or army vehicles on loan to the Department were so converted.

2. It has been mentioned that different provinces had different rationing schemes for food ; eventually a central scheme was evolved that fitted in generally with the provincial schemes and after its inception the Survey of India was better off, though the difference was more imaginary than real for by that time the central government employees had had time to shake down into the provincial systems and the necessity therefor and to reconcile themselves to adulterated *atta* and to proportions of rice/*atta* that they had previously been unaccustomed to eat. Some mention of this is made under *Bengal*. See also *Pay and Allowances*.

That there was some malnutrition there is no doubt ; apart from the increased costs of grain, even though subsidized on the ration schemes, increased costs of other essentials reduced the purchasing power of the lower paid personnel and the increasing sickness towards the end of the war and the general lessening in output per man reflected more than war weariness. Personally, my wonder was why we did not have more sickness and how we were able to carry out so much work against time in 1944-46.

3. It has also been mentioned that the shortage of petrol caused us some difficulty, making touring with private vehicles nearly impossible ( see *Tours* ) and with Government owned ( civil ) vehicles difficult. It was some time before it was appreciated that the army vehicles were using far more petrol than they need do ; before this was appreciated, we made good use of our loaned army vehicles, after it, it was easier to use our own vehicles for the rations became freer.

Owing to shortage of Government owned passenger vehicles the lack of petrol for privately owned cars put serious restrictions on the essential movement of officers ; rather, on the time they could spare for tours.

4. As with all Government services, paper had to be carefully conserved except printing paper which we must of course use to

provide maps for the armed forces. "Offcuts" (in cutting maps to size) formed a main source of "waste" paper for notes and scribbling and for most of our technical computation, etc., forms. Many tons were also handed over to the Stationery Department. The reverse of superseded maps also formed a useful source of paper for many purposes, provided the map was not classed as "Restricted" or some higher security category.

## RECESS

In the Survey of India, this term means the non-field season; that is, the season in which fair drawing and other office work is done, and during which personnel may take short leave. Leave is not usually granted during the field season.

The Survey of India meaning is different from the official meaning in the Government rules.

2. A considerable portion of the Survey of India spent the war "in recess", there being relatively very little field work.

## RECONSTRUCTION

This rather vague term was used somewhat indiscriminately in official documents. In this book it is used to mean the work taken up during the later stages of the war and immediately after it to develop Indian resources, particularly in respect of water power and irrigation, and mineral resources. So far as the Survey of India was concerned, there was little "reconstruction" in the strict sense.

2. Because the Survey of India was in a more or less permanent state of transition from about 1943 till the end of 1946, this book covers the period 1939-1946. "Reconstruction" projects were commenced as early as 1943; on the other hand, the Department was still producing many ex-India maps for the army in 1946 and many of its trained personnel were still in military employ. The "War" did not really end for the Survey of India till 1946.

See *Projects and Training*, Chapter X, 138-146 and Chapter XI.

## RECORDS

Personal records are dealt with under *Documents and Survey Depot*.

2. Certain technical documents are classified as "original records" and are very carefully looked after; see *Fair-Drawing, Map Record and Issue Office* and also *Burma*.

See also *Reports and Returns* and *History*.

## RED DEMANDS

These were special forms used by the Director of Survey (India) to demand publication from the Survey of India which are

explained under "*Green Demands*", the form used for drawing demands.

## RE-EMPLOYMENT

A number of officers who had retired before the war began volunteered for re-employment in any suitable capacity and the Survey of India was very glad to take advantage of their public spirited offer. This enabled younger (serving) officers to be made available for military units.

Few officers actually retired during the war, being retained after date of superannuation either on extension of service or on immediate re-employment. See Table G.

## REFER TO BOXES

There was always some difficulty in describing precisely the map required to ensure that *identical* maps were used by all concerned. To overcome this, a note which was enclosed in a heavily lined "box" was conspicuously placed on all maps for military use—"Refer to this map as so and so". See *Hind Maps*.

## REPORTS AND RETURNS

The regular annual General and Geodetic Reports of the Survey of India were published in full for 1939; to save labour and publication power, much abridged reports were published in 1940 and 1941 and suspended thereafter.

2. In July 1941 the Government of India required the Surveyor General to provide a brief report summarizing the war work of the Department up to date; this was issued up to and for July 1941 and continued thereafter for the year August-July inclusive. Called the "War Activities Report", it was "Secret" ("Confidential" after the change in classification of documents) with very limited distribution to Government, Army and Survey of India senior officials.

This report consisted of about 7 to 10 type-written pages *plus* four tables to indicate :—

- A. Disposition of units and offices.
- B. Personnel strength compared with 1939.
- C. Map output compared with 1939.
- D. Map output of military units in India Command.

The list of military units and maps was included because the Government of India desired an overall view of the survey and map publication with which it was concerned either directly or by providing some of or all the man-power.

3. Compilation of the War Activities Report was done by the Surveyor General personally, from information supplied monthly



by directors of the work in progress in their circles. The latter reports form a fairly complete detailed record of all work carried out during the war.

This report seemed to be a serviceable form of report to meet the needs of the Government as well as military authorities in India and neighbouring countries and at the War Office.

No war diaries were kept in the Department and peace-time routine progress reports were dropped.

4. From 1942, the Director of Survey ( India ) issued a monthly report on the working of the military service in India Command. This report and those of the Directors of Survey in neighbouring theatres kept the Surveyor General *au fait* with what went on and in a position to plan ahead because of this up-to-date information.

5. From time to time, the Government of India called for very brief special reports to be laid before the National Defence Council emphasizing any new large projects, of any sort, undertaken since the last report.

Otherwise, reports were few and routine returns were simplified and cut to a minimum though some, such as promotion and increment rolls, were very heavy because of the expanded size of the Department and the difficulty of accumulating information. See *Administration and Military Circle*. Also *Documents*.

The budget was naturally difficult owing to so many rapid and unforeseen changes ; much more than normal latitude was, however, given to us by the Finance Department and we were never in any serious budget difficulty.

6. The first Civil Activities Report, covering the period 1939-45 very briefly, was issued in 1945. Another was issued to cover 1945-46 after which regular reports were re-started.

## RESEARCH

See *War Research Institute*.

## RESERVATION OF POSTS

Some embarrassment was caused by Government orders about reserving a percentage of posts after the war for officers and men who had been employed in the armed forces, without regard to the service in which they had been employed. The Survey of India had by 1945 become very heavily involved in important and urgent surveys for reconstruction projects and could not afford to lose trained men, military or otherwise, nor could it afford the time to train men released from the army who had no previous survey experience, if men already trained were available.

This difficulty sprang from the failure of non-technical administrative officers to understand the requirements of technical services

and the time taken to train technical personnel. It is no doubt common to all countries.

## RESERVES ( MILITARY )

At one time, civilian Survey of India Officers were permitted to join the Indian Army Reserve of Officers, or Volunteer Corps. A number of officers who were reservists or volunteers were called up in the 1914-18 war and served in various theatres with distinction. After this war, permission to join reserves or volunteer corps was withdrawn because it was likely to result in survey officers being demanded for non-technical duties just when they were most wanted for survey duties; training also was likely to occur during the winter ( field ) season, when officers could least be spared. See *Military Organization*.

There were no Survey of India officers in the military reserves or volunteers, in 1939. A number of reserve officers, however, joined the survey service from 1939 onwards, and received R.I.E. commissions ( E.C. ).

2. Except for its cadre of regular military officers ( see *Cadres* ) the Survey of India therefore had no officers at call for military service in 1939; it depended entirely on volunteers. Before the war, volunteer lists were well filled and they continued to be well filled after the war started, but often ( in effect, if not in writing ) in the volunteer's own good time; no compulsion as to time could be exercised and this made it excessively difficult to form units. Briefly, there was too much "humming and hawing" among the volunteers many of whom sat on the fence until they were assured of adequate financial treatment, for which I am bound to say they could not be blamed. See *Terms of Service*. Rank also was a more or less uncertain quantity, and officers were very diffident about coming forward unless they were sure that their civil status and seniority would be recognized; in this too, I fully agree. It has already been stated ( *Promotions* ) that it is essential to correlate civil and military rank if morale in a technical service is to be maintained.

The result was, after considerable effort, the formation of the Survey Supplementary Reserve into which officers and other ranks could be drafted, with legal liability to serve when required to do so and with—which had been lacking in the volunteer system—remuneration for accepting this liability.

3. This Supplementary Reserve system also applied to other than officers, as has been stated above. Previously, the only persons at call for military service were a few soldier surveyors on the Indian Unattached List ( I.U.L. ) and the very recently formed Reserve of Surveyors. Before the formation of the latter, soldiers entering the Survey of India via the Roorkee survey course ( see *Soldier Surveyors* ) had the option of remaining in the I.U.L. and taking I.U.L. pension rates or being discharged completely from

the army, with no further military liability, and receiving civil pension rates. The majority took discharge ; to correct this situation for war, the Reserve of Surveyors was formed in 1940.

### “RESTRICTED”

Towards the end of the war, documents that had hitherto been classified as “For Official Use Only” or “Not To Be Published” were reclassified as “Restricted”. See *For Official Use Only*.

### RETRENCHMENT

Many war expanded Government departments suffered heavy retrenchment with the end of the war. Very heavy post-war survey commitments fortunately prevented its occurrence in the Survey of India and there was a place for all ex-soldiers who desired to have one, provided they were considered to be up to the required standard.

### ROYAL AIR FORCE

Most of our photography for air surveys before the war had been done by the R.A.F., confined as they mostly were to the N.W. Frontier of India. A considerable amount, however, had been done by *Indian Air Survey and Transport Ltd.* under which heading their work is outlined.

During the war, the R.A.F. was busy with operational work and we relied on our charter with the above named private firm, who were supplied with materials by the R.A.F. because of the difficulty of obtaining them through civil agencies.

2. The establishment of a photo library by the R.A.F. is also mentioned under *Libraries*, and the difficulty of obtaining a large aircraft for a special and important job, under *Assam*.

3. Before the war and for some time during its currency, maps were demanded by and supplied to the R.A.F. direct, and aeronautical maps had been designed to meet their requirements. After the formation of the Geographical Section, General Staff, R.A.F. demands were met via the Army.

### ROYAL ARTILLERY

Exercises in co-operation with the R.A. had been carried out from time to time before the war, culminating in two exercises of considerable proportions in 1938 and 1939. See *Frontier Circle*. The Survey of India was well informed on artillery survey methods but had little need to use this information during the war except indirectly. Those of its officers who were in military units, however, benefited by the training that had been carried out before the war and it is hoped that the benefit was mutual.

## ROYAL ENGINEERS

The Corps of R.E. had provided the majority of the Class I service of the Survey of India ; also during the war a considerable number of officers ( E.C. ) and B.O.R.'s were attached to the Department, see *Cadres*.

## ROYAL INDIAN ENGINEERS

With the formation of the Corps of Indian Engineers recruiting policy for the military cadre of the Class I service of the Survey of India was modified to cater for more Indian Army officers (Engineers) and less Royal Engineers and Indian Army ( other than Engineers ).

At the outset of the war, there were two I.E. ( now R.I.E. ) officers in the Department and a third joined soon after ; only one, Captain J. S. Paintal, R.I.E., remained in the Department after the war.

2. Emergency commissions granted to civil officers of the Survey of India were granted in the R.I.E. and those granted Viceroy's Commissions or enlisted in the army also became members of that Corps. Soldier Surveyors trained by us and accepted for the military survey service were transferred to the R.I.E. if not already in the Corps.

3. There were four Indian Army officers ( non-engineer ) in the Department in 1939, see *Indian Army*.

## RUN

In printing parlance, this term is used to mean the number of sheets of paper running through a printing machine before the inked-up printing medium ( zinc plate, stone or type, etc. ) is changed. For example, in peace time "runs" of 500 or so were the rule.

In the war, runs up to 10,000 were common. On completion of a run for any map, the machine has to be washed and cleaned and fresh printing plates introduced. See *Pull* and *Impression*.

## SAC SEA

Supreme Allied Commander, *South-East Asia Command*.

## SCALES OF MAPS

See *Map Scales*, *Map Policy*.

## SCIENTIFIC WORK

This term has been used to cover the special geodetic, geophysical, tidal, computational and similar work normally undertaken by the Geodetic Branch of the Survey of India, later passed to the War Research Institute when it was formed in 1943-44 so as to enable the Geodetic Branch to concentrate on its much expanded map publication and other work.

2. Some gravity work and some precise levelling was in progress when the war commenced but this was gradually dropped and by the end of 1941 none but work essential to war requirements, such as tide prediction, was continued.

As the war moved eastwards, however, scientific requirements greatly increased—special tide predictions, a great quantity of computational work connected with triangulation adjustment and the preparation of trig. data for the invasion forces, research in special astronomical methods, etc., and gravity and other measurements in connection with development of mineral resources.

The arrival in India of Dr. J. de Graaff Hunter, C.I.E., F.R.S., who had before his retirement been Director of the Geodetic Branch enabled us to create a new scientific branch, the War Survey Research Institute, without weakening our directing staff on other lines.

3. From 1944 onwards, the Institute was increasingly busy first on war work, then on assisting in the development of methods to be used during reconstruction work.

Details are contained in the relevant headings such as *War Survey Research Institute*, *AID Survey Framework*, *Gravity*, *Triangulation* and Chapters X, XI paras 155–161.

## SECRET DOCUMENTS

Maps published by the Survey of India were not classified “Secret” or (under the later classification of documents) “Confidential”.

Other secret documents were handled under normal military rules. See *Documents*.

## SECURITY

The question of security in relation to maps is a very difficult one, much more difficult than in relation to most other documents. To leave an area blank on a map is merely to draw attention to it besides irritating the bona fide map user; to put in fictitious “information”, not only is very troublesome, but will inevitably bring the map making organization into disrepute. The only course really open is to restrict, to greater or less degree, the issues of maps that contain military information.

Certain of our maps were therefore classified “For Official Use Only” (F.O.U.O.) before the war, later altered to “Restricted”; and in the early stages of the war, an extra category was added, “F.O.U.O.-B” which, while restricted was not so tightly so as F.O.U.O. See *For Official Use Only*.

2. In the case of maps being published for operational use a coding system prevents unauthorized knowledge of where maps are going, but there is always danger from within the publication office

itself. I am proud to record that, to the best of my knowledge, there was no leakage whatever from the Survey of India.

The Survey of India offices were classified, like military offices, as "Protected Places" and a pass system somewhat like that in use in G.H.Q. (India) was in force in many of them, with the object of excluding unauthorized persons; we also maintained a security force, including in certain cases plain-clothes detectives of the C.I.D.

3. Secret documents were dealt with as in military offices and, so far as possible, all secret information kept off paper and communicated by word of mouth. The usual posters etc., exhorting silence on military subjects were displayed, as in all other offices. The principle was followed, as with maps, of drawing the least possible attention to anything that might be regarded as information useful to the enemy.

4. There was some pressure for military officers to wear uniform on security grounds. I was unable to see its value, in fact it appeared to me that the reverse would be the case for uniforms were sometimes taken too much for granted, in various offices.

See also *Uniform, Documents, Map Issues*.

## SERIES OF MAPS

See *Map Series* and *Map Policy*.

## SETTLEMENT SURVEYS

"Settlement" surveys are those made from time to time by the provincial Governments for the reassessment of land values for taxation, etc., purposes. In some provinces, notably the Punjab and the N.W. Frontier Provinces, the Survey of India was frequently asked to provide the basic framework to control such surveys so that they shall be well co-ordinated. The detail survey work was done by the Settlement authorities, sometimes with assistance in training from the Survey of India.

In specially difficult cases, such as the settlement of hill and mountain areas, the Survey of India was asked to break down the major control still further. It was in such areas that the Department carried out a considerable amount of settlement survey work during the war, utilizing the surveys as advanced training in theodolite work.

See *Hazāra, Kulu, Triangulation*.

## SLOTTED TEMPLET ( TEMPLATE )

This is a mechanical device for adjusting minor control plots in the radial line method of air survey, see *Air Survey*, 3.

## SIAM

Siam possessed a sound survey department and there were some reasonably good maps which the Survey of India had occasion to duplicate during the war, mainly on the  $\frac{1}{4}$ -inch scale. Triangulation had also to be adjusted to fit with neighbouring Burma and Malaya triangulation, see *War Research Institute*.

In duplicating the Siam map series, we had some difficulty with the script, there being few Siamese scholars in India and there being also several methods of transliterating the Siamese characters. A scholar was, however, found who did most of the transliteration work for us, which was based on the "Bangkok Times" system.

2. A few Survey of India officers and men were employed in Siam towards the end of the war but little survey work was done there by our personnel.

3. See also *Spheroids*.

## SOLDIER SURVEYORS

It had been the practice before the war to take into the Survey of India each year about four soldiers who had completed and passed high in the survey training course held annually in the training establishment of the K.G.O. Sappers and Miners at Roorkee. These men, of various ranks from sepoy to havildar, then underwent five years' training in the Survey of India of which the first two were "first period", the men remaining on the books of their regiments, the "second period" being on the books of the Survey of India, on civil rates of pay.

At the end of the second period of training, men had the option of remaining on the Indian Unattached List (I.U.L.) or taking their discharge from the army; in the former case, they had a commitment to serve in the army when required to do so by the Commander-in-Chief in India and eventually received I.U.L. pension; in the latter case, they had no military commitment and received civil pension. Which a man took depended on his own assessment of his personal ability, civil pension being higher if a man got on quickly, lower if he did not.

2. Shortly before the war, the I.U.L. was being allowed to go out of existence. At the same time it was decided that, to ensure a reasonable number of surveyors having a definite military commitment, *all* soldier surveyors coming to the Survey of India must be included for some years in the Military Reserve of Surveyors. This was the position when the war started but the reserve had been in operation for such a short time that we had relatively few men with a definite military commitment; the majority of ex-soldiers volunteered for military service. See *Reserves*.

3. The bulk of the recruitment of surveyors to the Survey of India, however, was from civil sources and many of the civilian

surveyors also volunteered. As the war progressed and the army was tapping the same recruiting resources as the Survey of India, the supply of civilian recruits dwindled ; furthermore, the Survey of India had no resources for the education of recruits in the quantities that they were needed whereas the army had its normal educational system in full swing.

It was therefore decided that resources would be pooled and that for the period of the war the Survey of India would rely almost wholly on recruitment of surveyors via the army. Because of the bulk supply required and the pre-occupation of the Sappers and Miners with other matters, the Survey of India took over all surveyors' training from the start, the equivalent of the Roorkee-course being incorporated in our shortened first period of training ; the Survey of India advanced training being given in our second period.

Army Orders to this effect were published, and a first batch of 100 would-be surveyors called for. About 70 were actually received in the training party. See *Training and Training Parties*.

4. At the outset there were some vicissitudes. We had retained the pre-war scheme of first period in regimental books, second period transferred temporarily to Survey of India, permanently at end of second period with commitment to military service. First period had been shortened to one year (on average, flexible) second to not more than two years but a man could be considered to be a full-fledged surveyor as soon as his instructors thought he was up to the requisite standard. Men who were not up to standard were either relegated to other survey duties (drawing, map store-keeping, etc. ) or returned to their regiments.

This scheme did not meet with the approval of the men themselves who saw in it loss of prestige, loss of chances of promotion if returned to their regiments as unlikely to be a surveyor ; the Surveyor General had several conferences with the men and while there was undoubtedly some idea of "having it both ways", nevertheless the grievances were sound enough. The system was then changed so that men did not join the Survey of India at all but continued to remain on regimental books until, if accepted for military survey duty, they were transferred to the Corps of Royal Indian Engineers.

Even this scheme did not attract good men until trade pay was introduced for surveyors ( see *Trade Pay* ) after which there was little difficulty.

5. Though these surveyors were paid at military rates entirely, it was necessary to assess their worth annually on the civil pay system to provide for their possible entry into the Department after the war ( the Department did practically no civil recruiting and was relying on these men to provide its surveyor-power after demobilization ) and also to carry out normal promotions on the civil system of unclassified, second, first and selected grade surveyor to assess their military rank and hence pay in the army. Army



rank varied from havildar to subedar-major according to their classification and service. See *Terms of Service*.

6. Up to 1946, few of these men had decided to join the Survey of India, regarding the pay scales as too low. There was, I am afraid, a feeling that once the war was over war pensions or/and grants of land would provide for the remainder of their lives. I had talked personally to many of these men and tried to disabuse them of this somewhat fantastic idea, but to no avail.

Those who did join the Department required refresher training in the field and advanced training to meet post-war civil needs.

7. Because the system outlined above replaced our normal recruitment system, these Soldier Surveyors have been shown in Table C as if members of the Survey of India.

## SOUTH-EAST ASIA COMMAND (S.E.A.C.)

When the South-East Asia Command, and later the Allied Land Forces, South-East Asia (ALF SEA) headquarters formed, the Survey of India ceased to have any direct connection with the war in the Far East Theatre, all dealings being through the Director of Survey (India Command); it did, however, produce many hundreds of thousands of maps for this Command and provided and/or trained much of its survey personnel, besides carrying out considerable research work on its behalf.

It also provided the *Stores Organization* for that Command and acted as its survey *Base Organization*, which headings give some details about the work carried out, as well as *Map Publication*.

2. The present Surveyor General, Brigadier G. F. Heaney, C.B.E., was appointed Director of Survey in this Command but actually functioned with ALF SEA (at the outset, 11 Army Group). A staff directorate was also formed at the headquarters of the Supreme Commander (SAC SEA) whose business was to interpret military information from a survey and mapping point of view and keep D. Svy. ALF SEA informed. This headquarters also undertook any drawing and publication work required by SAC SEA itself.

Many Survey of India officers and men served in this Command as also personnel who had been trained by the Survey of India. See Table E.

Survey of India officers and men in this Command were as far afield as Indo-China and Netherlands East Indies and the Department published many millions of maps for it up to and including Tokyo. See also Chapter IX, 124-127 and X, 135.

## SOUTHERN ARMY

The Southern Army replaced Southern Command (India) in 1942 when Japanese invasion of India appeared imminent and in

1943 a Survey Directorate, with several military survey units under its control, was formed. These units were very busy on surveys and mapping connected with the defence of the east coast until the Japanese threat was removed after which they carried out intensive training before becoming part of South-East Asia Command ( ALF SEA ) in 1944.

Map publication was carried out very largely by the Madras Survey Department during this period, see *Madras*, and assistance as required was supplied by the small South India Detachment, see *South India Party*.

## SOUTH INDIA PARTY

There had been a full circle of the Survey of India in south India with headquarters at Bangalore up to 1932, after which a strong "Independent" Party had been functioning there under the direct control of the Surveyor General.

Until the spring of 1941, this party continued to function as such being one of the few units to continue a routine field programme, necessitated by the inadequacy of the maps of the area south-east of Bombay. In April 1941, however, the party was reduced to detachment status, most of its personnel joining the *Eastern Circle* in Dehra Dūn, for drawing duties. The South India Detachment in Bangalore looked after what little work there was in southern India until the Southern Army Survey Directorate took over in 1943, when there was a great deal of work in connection with the defences of the east coast and military training and map publication, see *Southern Army* and *Madras*.

The S.I. Detachment assisted the D.D. Svy. Southern Army as required.

2. Reconstruction projects of some size took shape in southern India in the later stages of the war and immediately after it, and heavy demands for maps and new surveys had been made by the provincial and state Governments concerned.

The Southern Circle was therefore re-established with headquarters at Bangalore in 1946. See *Tungabhadra* and *Projects*.

3. The hired offices of the South India Party were retained in Bangalore throughout the war, a large part of them, however, being used for military purposes.

## SOUTH-WEST PACIFIC COMMAND

This command, formed shortly after Japan invaded Malaya, was dissolved after the fall of Singapore and Jap invasion of Java. A Survey of India officer, Colonel G. Bomford, was appointed Deputy Director of Survey in charge of the Command Survey Directorate. He remained but a short time in Java but succeeded

in bringing back to India some very valuable cartographic records of the N.E.I.

## SPHEROIDS

All maps of India and Burma were based on spheroid data deduced by Sir George Everest, Surveyor General of India from 1830 to 1843 and Superintendent of its Great Trigonometrical Survey from 1823 to 1843. These data differed from those accepted for 'Irāq to the west and Siam to the east, as well as those accepted for Malaya and N.E.I. and Indo-China.

Where triangulation and maps based on one set data joined another, there was therefore some difficulty. While each set of maps and trig. values were coherent in themselves, each introducing minimum error within their own spheres, the "marginal adjustment" where spheres adjoined presented a considerable problem to our scientific staff and resulted in a great deal of work in the War Research Institute.

The discrepancy as between India and Irān based on 'Irāq was not troublesome, not because it did not exist but because it was gratifyingly small and there was no war interest at the junction (see *Baluchistān*). In the case of Siam and other countries to the east, however, separate sets of tables had to be prepared and separate sets of triangulation data based on the two adjoining spheroidal data, with conversion tables to put triangulation in one set of terms into the terms of the other.

2. This book is not the place for a dissertation on geodesy but it may be explained for the benefit of the non-survey reader that while the earth is approximately a spheroid, it is not exactly so; to enable calculations to be made for the solution of triangulation and similar problems, assumptions have to be made for the size and shape of the true spheroid that most nearly fits the earth, and at what places this true spheroid will touch the earth's surface. It is in these assumptions that the discrepancies between the various spheroids of calculation lie. Coupled with differences in projections, discrepancies may be considerable. So also *Projections*, *Grids*.

## STATIONERY

Ordinary office stationery was obtained from the Central Stationery Department of the Government of India, and this department also supplied a considerable amount of technical stationery in the earlier stages of the war.

The Survey of India and the military survey service, however, required an increasing amount of stationery articles of special type and quality not ordinarily stocked by the Central Stationery Office, such as high quality drawing pencils, inks, colours, papers, etc., and

it was eventually arranged with the War Office and agreed by the Stationery Department that such supplies should be made direct from Britain or U.S.A. to our Stores Organization. As far as available, however, supplies normally held in India were used and wherever possible, Indian made articles.

Printing and drawing papers have been dealt with in more detail under the head *Paper*. See also Chapter VIII, 117.

## STORE-KEEPERS

There was no Survey of India Stores Organization before the war and besides a few map store-keepers in the Map Record and Issue Office no one was specially trained in storekeeping duties; it was usual in the parties and field circles to employ elderly surveyors, draftsmen, computers, etc., on these duties or to combine them with clerical duties.

The development of the Survey of India Stores Organization during the war and the great increase in map output as well as the formation of military Map Supply Sections made it necessary to recruit store-keepers specially for their work, and train them in their duties, besides introducing special pay scales to attract suitable men.

See *Stores Organization, Map Issues*.

## STORES ORGANIZATION

Before the war map publication machinery, chemicals, inks, drawing and printing papers and certain other special stationery articles were demanded from the India Stores Department, London, by the Director, Map Publication who consolidated the indents of the various circles and units in respect of these stores. Indents were submitted a year or more ahead and the articles, as they became available, were shipped piecemeal direct to the various indenting units in various parts of India.

There was no central storage for such articles, though the Map Publication Office did keep a small reserve stock in case of unforeseen demands before the next indent, or emergencies. There was no Stores Organization as such.

2. Certain technical stores (other than printing stores) and instruments, etc., were similarly obtained on indent from the India Stores Department, London, partly through the Mathematical Instrument Office, partly direct by units on indents through the Surveyor General's Office.

Other instruments and stores were obtained on indent from the M.I.O. who held a small stock of some articles, manufactured or purchased others to meet the various indents.

Still others were purchased direct by the units requiring them, or indented for direct on the Indian Stores Department in India.

The latter organization also kept no stock but caused the manufacture of the required articles and their despatch direct to the indenting unit.

3. As the Survey of India took over the rôle of *Base Organization*, requirements increased, sources of supply disappeared or were overwhelmed with orders and transport and shipping tightened up, it became necessary to establish "stock-piles" and to have one central authority in the Survey of India who could deal with—and to some extent foresee—the requirements of the various units.

A modest start was made in August 1940 when the Director, Map Publication found that too much of the time of his printing and connected staff was being spent in dealing with stores; his Deputy, Lt.-Colonel G. W. Gemmell, I.A., was allotted the task in addition to his other duties of forming a small organization that would control the stores situation as it applied to the Publication Circle.

In April 1941 the organization, by now expanded somewhat, moved to Delhi and was taken over whole-time by a retired officer of the Royal Engineers, at one time in the Survey of India (Colonel O. H. B. Trenchard, R.E.). While organization could be done in Delhi, there was little room for creating and storing stocks nor was Delhi a very suitable place for them, the technical activities of the Department being elsewhere. The organization was therefore moved to Dehra Dūn where buildings were hired to accommodate its office and its increasing stocks of all sorts of survey equipment and stores. The Mathematical Instrument Office having been transferred to the Supply Department in May 1941, we could no longer rely on that office for instrument storage and stock-piles and hence had to expand still further to ensure that we had sufficient instruments, etc., under our own control.

4. For some time the Stores Office had to function in quite inadequate hired bungalows of the residential type. This was difficult for the organization and also was detrimental to the increasingly tight accommodation situation in Dehra Dūn. There was considerable pressure on us to vacate these bungalows, from local Government sources.

Steps were therefore taken to build proper stores accommodation and offices in the Geodetic Branch compound and with the formation of the South-East Asia Command comprehensive accommodation became essential because the Survey of India Stores Organization was to be in a position to supply that Command.

This accommodation consisted of large stores and an office building. In addition to articles stored in the buildings, a considerable amount of heavy plant had to be stored outside when the whole weight of the war turned to the east.

5. The growth of the organization is indicated by the fact that whereas in 1941 about 240 separate items were under supply, in 1945 about 3,500 major items were handled and nearly 10,000 when

all items are included; tonnage handled increased from about 35 tons in 1941 to 7,600 in 1945.

The range of stores was very wide, including some 17 different types of modern lithographic printing machines with printing surfaces varying from 13"  $\times$  8" to 48½"  $\times$  36½", ancillary equipment, a large volume of spare parts, inks, chemicals, papers, photographic plates, films and papers; there was also much equipment to be handled as well as surveying and mathematical instruments.

Of the stores used in 1945 about 25% were Indian made, including over 2,500 tons of printing paper.

6. Not all items actually went to Dehra Dūn. Items of major plant being sent from U.K. to units in the South-East Asia Command, though dealt with on the books of the Stores Officer, were shipped direct from Calcutta or Bombay, in which places small Stores forwarding offices had been established under the control of Deputy Stores Officers.

These officers were also charged with the duty of locating survey stores (which were specially marked) at the docks and clearing them expeditiously to destination.

7. Procurement was in part direct from the Survey Stores Organization (War Office) in U.K., in part from the Mathematical Instrument Office in Calcutta, in part from the Indian Stores Department in India and (to a small extent) by direct purchase in India.

Indents were submitted on the various offices by known requirements with which the Stores Officer was kept in touch by the one hundred and twenty or so units, military and civil, that he was supplying, through their respective directors, military or civil; and by basing demands on averages for each type of unit. Demands on the War Office were made by the Geographical Section, General Staff, on Indian suppliers by the Stores Officer himself.

The Office functioned under the control of the Director Military Circle/Director of Survey (India). See *Military Circle*.

8. At the outset, it was possible for any survey-trained officer to fill the post of Stores Officer. As time went on, however, and more and more printing and similar machinery with spares, special inks, etc., came into the theatre, it became difficult to find an officer with adequate knowledge; one who knew about instruments was unlikely to know sufficient about printing machinery and vice versa.

As printing machinery and stores formed the most difficult and important part of the work, an officer was usually selected from the 'Officers' Cadre of British technicians, see *Cadres*; he was given an assistant with knowledge of surveying and mathematical instruments but relied for inspection for standards in these articles on the Mathematical Instrument Office in Calcutta; it had been agreed with the Supply Department that Mr. Malcolm (Mr. Lacamp after Mr. Malcolm's death) who was fully familiar with Survey of India requirements should do all inspections and that the Stores

Officer should correspond with him direct on these matters. See *Mathematical Instrument Office*.

Deputies and Assistants were also obtained from among civilians in India who had had stores or similar experience in the Railways, Public Works Departments, etc.

9. In 1945, the Stores Organization was as follows :—

Stores Officer ( Military Cadre, R.E. )	..	1
Deputy Stores Officers ( Class I, General Central Service )	.. ..	2
Assistant Stores Officers ( Class II, General Central Service )	.. ..	2
Officers ( of U.S.S. Status )	.. ..	2
Store-keepers ( 2nd Divn. Technical )	..	5
Assistant Store-keepers & Clerks	..	55
Class IV personnel, including Carpenters, Packers and Store-khalāsīs	.. ..	140

10. When Japan collapsed, a vast quantity of stores had been accumulated against invasion of that country. In addition, more and more stores were coming in that had been on sea when VJ occurred or that were returned as units employed in the S.E.A. Command were demobilized or reduced in strength. It was therefore necessary to keep the full strength of the stores staff going for a long time to deal with this influx, sort, list and prepare for disposal through the Disposals Directorate of the Department of Supply.

Concurrently, the Survey of India, starved for instruments in its earlier reconstruction projects work, had to be made up to strength in surveying and mathematical instruments—the Department by then being roughly twice its pre-war size and very fully occupied. See *Projects*.

The problem of what to do with the large quantity of printing plant installed in the Survey of India is discussed under the heading *Information and Broadcasting*.

## SUNDARBANS

This wild coast area between the Hooghly and Brahmaputra rivers, consisting of forest, mangrove swamps and tidal creeks, was inadequately surveyed to meet military requirements in the event of an attempted Japanese landing south-east of Calcutta.

During 1942–43 it was photographed from the air by Messrs. Indian Air Survey and Transport Ltd., under their charter with the Government of India but improvement in the military situation made it unnecessary to compile new maps from these photographs during the war.

See *Indian Air Survey and Transport*.

## SUPERIOR SERVICE

This is a somewhat vague term used to distinguish Surveyors, etc., from Khalāsīs (*Inferior Servants*). See also *Class I, II, III*.

## SURVEY DEPOT

The responsibility accepted by the Survey of India for the formation of a military Survey Depot in case of war has been mentioned in *Military Organization and Frontier Circle*.

The Depot was formed by the Frontier Circle, soon after war broke out, at Risālpur in the N.W.F.P. which was then the mobilization station for military units formed from the Survey of India. It was commanded by a military officer of the Survey of India who was assisted by a non-survey officer supplied by the army as adjutant and quartermaster and by a few army reservist V.C.O.'s and Other Ranks. The clerical staff and lower rank I.O.R.'s were found by the Survey of India ; a unit accountant from the army was added soon after.

The Depot remained in Risālpur until the end of 1942 when it moved to Dehra Dūn as being more central and convenient and more suitable climatically, Risālpur being excessively hot in summer.

2. The method of mobilizing personnel from the various civil units of the Department into the Survey Depot was troublesome, lacking an essential intermediate stage. A "Survey Training Centre" under the orders of a "Survey Training Officer" was therefore formed in the civil Department and was located with the military Survey Depot at Risālpur (later Dehra Dūn) and was commanded by the O.C. Depot who was authorized to perform this dual military/civil function. This particular name was selected to avoid confusion with the military Survey Depot, though the Survey Training Centre was in fact a civil wing of the Survey Depot, the Depot proper being the military wing.

Mobilization (and demobilization) problems immediately eased considerably, officers and men being first posted to the Survey Training Centre whence they stepped from one room to another and became soldiers, or vice versa on demobilization.

The Survey Depot and the Training Centre were under the same control, that of the Director Frontier Circle at the outset, from 1942 onwards that of the Director Military Circle on the civil side, the Director of Survey (India) who was also Director Military Circle, on the military side. See *Military Organization, Military Circle*.

Clerical staff was variously military or civil as necessary and available ; military staff had to be kept within war establishments, civil staff was at the discretion of the Surveyor General and was augmented by him as necessary in the Survey Training Centre.

Both military and civil personal records were maintained in the combined office.

3. It had originally been intended to allot most of the training tasks to the Survey Training Centre. This, however, became impossible owing to the size of the task, see *Training*. The Training Centre/Survey Depot did, however, deal with all training of



I.O.R.'s of the rank of Naik and below in their survey duties such as helio aligning, chaining, etc. See *Inferior Servants*. Training of surveyors, draftsmen, etc., was carried out in the *Training parties*.

The authorized strength of the Survey Depot/Survey Training Centre in 1945 was as follows :—

O.C. Depot/Survey Training Officer	..	1
2nd-in-Command Depot and Asst. S.T.O.	..	1
B.O.R.	..	2
I.O.R.	..	83

4. Officers and men on the Depot reinforcement strength were normally employed in neighbouring Survey of India offices while awaiting posting, demobilization, etc., and, particularly in the case of B.O.R. technicians, made a welcome addition to Survey of India map production potential in the busy times of 1944–45.

## SURVEYOR GENERAL'S OFFICE

Until 1940 this office, responsible for the headquarter administration work of the Survey of India, had been in Calcutta ; it had long been felt that it must be nearer the Government of India and it was moved to Delhi in 1940 where it occupied a portion of the old Temporary Secretariat on Alipur Road in old Delhi. The Surveyor General, with a tour office, had moved to Delhi in 1939.

The Assistant Surveyor General had always been a military officer of the Class I Service of the Department, usually a senior officer, but otherwise this office had no technical staff, the Surveyor General relying on his directors for technical advice. In effect, it was purely an administrative office. In the 1914–18 war it had held the personal documents of those on active service but did not do so in the 1939–45 war, see *Survey Depot* and *Military Circle*.

As accommodation in Delhi tightened up, the S.G.O. had to vacate its offices in the Secretariat proper but continued to occupy hutments close by, preferring this temporary type but fairly roomy accommodation to the certainty of being squashed up in the main Secretariat in New Delhi, or relegated to huts there—in any event, likely to mean constant movement and disorganization. See *Accommodation*.

2. Throughout the war, this was a very busy and harassed office. Apart from routine administration and technical and semi-technical, military and semi-military problems, it was the buffer between Government and its employees, between military and civil requirements and procedure. In his capacity as survey adviser to the Government of India, of which the Commander-in-Chief in India was a member, it was incumbent on the Surveyor General to keep an open mind on civil versus military demands.

3. A military officer performed the duties of Assistant Surveyor General up to 1942, assisted from 1941 by an additional Assistant Surveyor General, a civilian officer who had been promoted from

the clerical staff and who had had a very wide and varied experience of clerical and administrative work in the Department as well as in the 1914-18 war, Rai Sahib Diwan Chand Verma (later Rai Bahadur Verma, M.B.E. ).

Shortage of military officers precluded having one as A.S.G. from 1942 onwards, and the office was somewhat reorganized to have two Assistant Surveyors General, both civilians, one on the organizational side ( R.B. Verma ) and one on the administrative side ( Mr. O. N. Pushong, re-employed from retirement ). These two officers formed the mainstay of the Surveyor General's staff throughout the remainder of the war. Until its very late stages when reconstruction work was coming to the fore, the S.G. had to do without a military officer, relying on the Director Military Circle and his Assistant Director ( Brigadier E. A. Glennie and Colonel R. H. Phillimore respectively, see *Military Circle* ), who were also close by in Delhi for military advice and his other directors for technical survey and publication advice.

Towards the end of the war, the S.G. was fortunate in having military officers, Colonels G. F. Heaney and J. B. P. Angwin, as his deputies who were able to relieve him of a considerable amount of organizational work particularly on the military side.

4. In common with the rest of the Department, the S.G.O. was much expanded and suffered several reorganizations to cope with the vast increase of work and, by up-grading some of its posts to officer status ( civil ), was able to decentralize work to a considerable extent. At the outset, it suffered from over-centralization, being designed to deal with a comparatively small department working to a routine as compared, in the war, with a much larger department involved in heavy military as well as civil commitments.

Rai Bahadur Verma was instrumental in working out these reorganizations and getting them through the Finance Department, along with the many reorganizations necessary for the Department as a whole. The organizational work falling on his shoulders was very heavy, not only during the war but in the transition period from 1944 onwards. The administrative work too was very greatly increased, see *Administration*.

## SURVEYORS

The term "surveyor" was specifically applied in the Survey of India to those Lower Subordinate Service officers who were specialists in plane-tabling work. Those who were specialists in air survey work ( usually also expert plane-tablers ) were called "air surveyors" and the various other trades that were included under the *general* term surveyor were described by their names such as leveller, traverser, draftsman, etc.

This caused confusion at times and it was proposed before the end of the war to call plane-tablers by that name, reserving the term surveyor for its more general and proper meaning of any person

who specialized in surveying in any of its branches, whether "officer" or "other rank". See also *Soldier Surveyors*.

## SURVEYORS' TRAINING PARTY

A special training party ( No. 2 Party ) was formed primarily to teach plane-tableing and the preliminary drawing necessary for every plane-tabler to master. Air survey training was, however, carried out in No. 18 Party.

See *Training Parties* and *Air Survey Party*.

## SURVEY POLICY

Survey policy is intimately connected with *Map Policy*, both being outlined under that heading.

## SURVEYS

Surveys carried out by Survey of India personnel are mentioned under the appropriate headings such as *Hazāra*, *Irāq*, *Programmes*, etc.

## SURVEY SERVICE POCKET BOOK

A Field Service Manual had been published in 1916 detailing the survey organization for the 1914-18 war. Though war establishment had been prepared before the 1939-45 war, as well as war equipment tables and terms of service for civil officers and other ranks on becoming soldiers, there was no book of reference to enable civil officers to discover readily what they were supposed to do in war, nor any compendium of survey information that they could carry in their haversacks, like the military Field Service Pocket Book.

2. A loose-leaf type pocket book was therefore put in hand early in 1941, outlining military duties required of survey units, war establishments, approved military methods of making appreciations, writing orders, etc., and incorporating brief information about the various survey tasks that might confront survey officers and others in war, with formulæ, methods, etc., commonly met and used briefly stated or outlined.

Various officers best qualified to write the several parts were selected and instructed to complete their part ready for the press by 31st March 1941. This was done, and the first edition was published ( in Geodetic Branch, Dehra Dūn ) during 1941. The book was reprinted with amendments in 1942 and again in 1943, to meet heavy demands caused not only by our own expansion but also from outside survey and artillery survey sources.

Hastily written though it was, the book is a very valuable one and has been much used by survey and other connected interests.

3. The book is published in self-contained parts which can be bound in a folder of pocket size like that used in the Field Service Pocket Book.

The headings of the various parts are as follows :—

PART	I. Introductory.
„	II. Organization in war.
„	III. Mobilization.
„	IV. Appreciations, orders, messages and miscellaneous military notes.
„	IV(a). Instructions for survey signal messages.
„	V. Spare.
„	VI. Spheroids, projections, and grids.
„	VII. Scales and lay-out of maps.
„	VIII. Notes on instruments their uses and adjustments.
„	IX. Notes on observational procedure and methods.
„	X. Map reproduction.
„	XI. Organization for technical work.
„	XII. Air survey.
„	XIII. Formulæ and approximations.
„	XIV Map compilation.
„	XV Novel methods.

## SURVEY TRAINING CENTRE

This civil unit was in reality the civil wing of the ( military ) *Survey Depot* under which heading it is described.

## SYLLABUSES

Training syllabuses had to be altered frequently to keep up with changing requirements in the military survey service and at the end of the war to meet the needs of post-war reconstruction surveys.

See *Reconstruction, Projects and Training*.

## TAVISTOCK

See *Theodolites*.

## TECHNICAL STATIONERY

Technical stationery included special pencils, inks, water colours, etc., as well as paper, both for drawing and printing purposes, and a number of similar items.

Obtained before the war by direct indent on the India Stores Department, London, it was supplied during the early part of the war through the Stationery Department of the Government of India. This was an embarrassment to that department most of

whose consumers required only ordinary office stationery ; arrangements were therefore made with the War Office to supply us direct in respect of items not usually stocked by the Stationery Department from whom, however, we obtained as much as possible.

See *Paper* and *Stationery*.

## TEMPORARY COMPUTERS

See *Computers* and *Topographical Assistants*.

## TERMS OF SERVICE

In 1934, terms of service were drawn up by the Director Frontier Circle of the Survey of India in consultation with Army Headquarters and approved by the Government of India, detailing the ranks, pay, leave, incidence of cost, etc., of Survey of India personnel that would be militarized and mobilized in case of war. These were published in Government of India ( Army Department ) letter No. A-41739/Pt. VII/3 ( A.G. 4 ) dated 5-11-1934, and were the terms on which we had called for volunteers for military service before and during the early stages of the war.

In the 1914-18 war the Survey of India formed what were in effect civil units, personnel receiving "relative rank" and being permitted to wear uniform of the military type, but without Corps insignia. The 1934 terms of service allowed for the formation of combatant military survey units, with transfers of personnel to the army in the Corps of Indian Engineers, later R.I.E.

2. The terms of service referred to in the foregoing paragraph were for "general mobilization". It was argued that in 1939-40 mobilization was not general and hence the terms were inapplicable ; this caused a great deal of difficulty for us for no one knew where he was and hence hesitated to volunteer. The upshot was that fresh terms were hastily prepared, resulting in considerable ambiguity and the necessity for many amendments later on. The terms on which we worked during the war, subject to frequent amendments, were those promulgated in Defence Department ( Army Branch ) letter No. B-55824/1/A.G. 1 ( b ) dated 26-7-40.

3. In the case of military officers of the Class I Service, treatment was similar to that of regular army officers in other branches of the service ; substantive rank was retained and promotion to acting or temporary rank granted according to the military post held if the grade of the post was higher than the substantive rank.

Civilian gazetted officers were commissioned in the military rank laid down by the Terms of Service ; non-gazetted officers received Viceroy's Commissions in the prescribed rank and other non-gazetted personnel received Viceroy's Commissions or were enlisted in the rank prescribed, the lowest rank for superior service personnel ( Lower Subordinate Officers ) being havildar. Inferior

Service personnel (Khalāsīs) received the rank of naik, lance-naik or sepoy.

A table of ranks as finally evolved during the 1939-45 war is at Table B. As in the case of regular military officers, acting or temporary promotion was given according to the military post held, see *Promotions*.

The purpose of laying down initial ranks for the various classes of personnel of the Survey of India was of course to enable all ranks to know exactly what their status would be on militarization, before they volunteered; and also to ensure that civil seniority was preserved as far as possible, an important point for morale.

4. Pay was governed on the principle that each individual should receive whichever was the better, either the military pay of the post held or his substantive civil pay *plus* certain war additions in the shape of technical pay or special military allowances, laid down in the Terms of Service. The prescribed allowance rates are shown in Table B.

This was obviously a fair system; it did, however, make for heavy administrative work for changes in civil status and pay and changes in military rank caused civil pay plus allowances to be the better one moment and military pay of rank better the next; it also made it essential to keep up our regular annual increment rolls, see *Military Circle and Administration*.

5. At the outset of the war, no trade pay was granted to survey personnel and when granted later on, was a purely military matter and therefore did not enter into the Terms of Service as such. See *Trade Pay* and Table B.

6. The Terms of Service also covered the question of travelling allowance to and from the mobilization station, despatch of families to and from their homes, leave during and after militarization, disability pensions and family pensions in case of death, etc. These points were also of the greatest importance to individuals volunteering and the upset of the 1934 terms, referred to in para 2 above, was responsible for much delay in obtaining volunteers on this as well as the rank and pay account.

Some difficulties about travelling allowance and leave have been mentioned under those headings.

7. The incidence of cost as between civil and military budgets was also laid down in the Terms.

8. Apart from the heavy administration involved, the Terms of Service worked well on the whole. They succeeded very fairly well in maintaining civil *vis-à-vis* military seniority and status, without which we would have had many less volunteers and morale must have suffered badly.

The 1940 terms closely followed the 1934 in principle. See also *Reserves*.

## THAILAND

The country of Siam was for a time called Thailand. It has been referred to as "Siam" throughout this book.

## THEODOLITES

For routine work, the Survey of India mainly used simple vernier transit instruments, easily learned by traversers, etc., of relatively low educational qualifications. Micrometer instruments were used for higher precision work and glass arc instruments for highest precision and military work, in the former case for their accuracy, in the latter for their convenience and less bulk and weight, as well as ( weight for weight ) precision.

At the outset of the war, the Department had a somewhat heterogeneous collection of these instruments, Wild, Zeiss, Watts and Tavistock—the latter the latest development of the type, made by Cooke, Troughton and Simms to ( more or less ) British military specifications.

Most of our military volunteer officers, both gazetted and non-gazetted, had been trained in the use of the Wild theodolite ( 3-inch ), few in the use of the corresponding Tavistock. War Equipment Tables called for some theodolites of each sort, glass arc, micrometer and vernier; the latter included mainly because glass arc were hard ( and expensive ) to get.

2. As the war progressed and more and more survey units were called for, we were hard put to it to find enough theodolites; training had to be carried out and sufficient theodolites for this purpose retained in India; the Americans were absorbing a considerable number of Tavistocks and also the British units in the Mid-east and European theatres. It was not till quite late in the war that we were free of anxiety in respect of these instruments.

After the war, we had to call in all available instruments as quickly as we could to get ahead with post-war projects; apart from the Survey of India, there was a very heavy demand from the Public Works and Railway Departments who, however, were given the vernier type. Glass arc instruments were reserved for the Survey of India to whom indeed most of them in the eastern theatre belonged.

3. Training in theodolite work is discussed under *Training* and *Triangulation*, and also ( astronomical work ) under *Astro-fixes*.

## TIDES

Tides had been predicted as a routine measure by the Survey of India, and tide-tables published, for something over 40 different ports in the Arabian Sea, Indian Ocean and Bay of Bengal. This was done in the Geodetic Branch at Dehra Dūn using a tide predicting machine similar to that used by the Tidal Institute, Liverpool, England.

This work was continued during the war and, for fear of damage to the machine through enemy action or sabotage, predictions were kept two or three years ahead. There was no other machine in Allied hands nearer than Britain.

2. Besides the regular ports required for navigation purposes, tide predictions were required at certain special beaches, etc., selected for invasion of countries in possession of the Japs. The naval authorities also required charts to indicate the predicted height of water at *any* time at a number of extra ports and places, for which Dr. de Graaff Hunter devised a special fitting to the tide predicting machine.

During 1945, tide-tables for 1946 were published for 67 ports in the Indian Ocean and connected waterways ( 39 being predicted on the Survey of India machine ), charts to indicate the water height at *any* time during 1945 were prepared for 62 places, prediction of tides for 1947 and special charts for 57 places in 1946 were in hand.

3. The tide predicting machine, noisy but invaluable, was one of the few pieces of machinery protected by blast walls, etc., from the outset in the Survey of India organization in Dehra Dūn. It was indispensable and virtually irreplaceable.

## TISTA

Like the Kosi project, the Tista project seeks to control and utilize the waters of this great river that breaks out of the Himālayas from some of the highest mountains of the range. The problems are similar ( see *Kosi* ) and the project is bigger than the Kosi though of somewhat less urgency.

The Tista River comes down from the snowfields of Kānchenjunga and neighbouring very high Himālayan peaks and is joined, near Darjeeling, by the Rangit River from the west. In flood, it devastates the country in northern Bengal before joining the Brahmaputra and assisting that river to create still further devastation in its lower reaches before emptying into the Bay of Bengal.

2. The project envisages the construction of several dams and barrages and the command of some 10,000 square miles of country in irrigation; preliminary work was done on it, and estimates framed and plans made, during 1944-45 concurrently with a very heavy rush of war work. Work was started on the survey side of the project in earnest by the Eastern Circle in the field season of 1946-47. Preliminary surveys had been made earlier by methods described under *Projects*.

## TOPOGRAPHICAL ASSISTANTS

The genesis of this service of the Survey of India is outlined under the heading *Computations and Computers* from which it developed. It is perhaps incorrect to speak of it as a service though



it did, virtually, become one, temporary though it was. When the war ended in 1945, there were 97 Topographical Assistants ( "T. A.'s" ) on the books of the Department, of whom 25 were at that time, or had been at one time or another, on military service in various capacities.

2. Without going into the details outlined under *Computations* the necessity for this service arose out of the fact that the Upper Subordinate Service of the Department, consisting in recent years of university graduates, was underpaid for its quality while at the same time the Lower Subordinate Service was of inadequate education to undertake any survey duties that required mathematical ability and the ability to understand fully the use of the theodolite and similar instruments and the computations connected therewith.

Recruitment to the U.S.S. was therefore stopped and temporary employees, who could be recruited under the Surveyor General's own financial powers, were substituted to meet war needs ; these were mostly university graduates with either mathematics or geography as one of their university courses, or both.

In the later years of the war, candidates were required to volunteer for military service before being accepted. Their training course was very similar to, though shorter than, that given to Class II probationer officers ; in fact, a number of T.A.'s later became Class II officers, and a number received commissions in the army.

3. There was no fixed pay for Topographical Assistants. The first batch was recruited at Rs. 60/- per month, but as the cost of living increased, the starting pay had to be correspondingly raised, and suitable increments given to previous incumbents ; no rate of increment was fixed, being granted according to merit though a regular annual incremental system was followed basically on the grounds that a man with two years' experience was likely to be better than a man with one and so on. Some men were taken in at considerably higher pay than the minimum on account of age and previous surveying experience ; after the first batch, graduates were started at higher pay than non-graduates.

The "service" being purely a temporary one, there was no pension commitment and no commitment to retain them in the Department after the war. Actually, a large number were absorbed because of our expansion, and our extreme need of experienced personnel to get started quickly and efficiently on reconstruction projects work.

4. The formation of this "service" introduced in the Survey of India a new system, one that had been the subject of controversy for some time, namely the utilization of a less number of better educated men at higher pay rather than a greater number of less educated men at lower pay. It is perhaps early to say for sure whether the system is advantageous, but without it, we would not have been able to maintain the army units or to have got started as we did on post-war work.

The normal recruitment system for Class II and Upper Subordinate officers was too cumbersome and slow to meet war requirements ; this is understandable because recruitment to these regular services definitely committed the Government to permanent service and pensionary prospects ; great care had therefore to be taken in selection. The recruitment of Topographical Assistants committed them to nothing.

5. I think that on average, a few Topographical Assistants were better than normal Class II standard, a very fair number were up to it and perhaps half those recruited were not up to it though up to Upper Subordinate standard. Only a few were below U.S.S. standard.

### TOPOGRAPHICAL HANDBOOK ( T.H.B. )

The Topographical Handbook of the Survey of India is the Department's technical book of reference and instruction, as the General Handbook is its administrative counterpart.

The book consists of twelve chapters each published separately in paper binding and covering all aspects of topographical survey, mapping and map publication as practised in the Survey of India.

2. A number of copies of this handbook were carried by each military unit and every officer is supplied with one on recruitment ; all junior officers are examined annually in their knowledge of it.

The book was too bulky to carry about in the field, though a few chapters should be and were carried by individuals, such as those covering Triangulation, Plane-tabling, Surveys in War and Air Survey.

The *Survey Service Pocket Book* was designed *inter alia* to provide an abbreviated book of reference and instruction, though not held to be authoritative. The T.H.B. is authoritative, containing the orders of the Surveyor General on all the technical subjects covered.

### TOPOGRAPHICAL MAPS

The  $\frac{1}{4}$ -inch was the smallest scale topographical series produced by the Survey of India, 1/25,000 being the largest scale except for a few town guide maps on scales up to 6 inches to a mile.

The Cantonment maps, usually on scale 16 inches to a mile, were partly topographical in that they showed hill features within their boundaries but were more in the nature of cadastral maps.

See *Map Policy*, *Map Series*, *Map Scales*.

### TOPOGRAPHICAL PROGRAMMES

General policy is outlined under the heading *Map Policy*, peace-time survey programmes following the policy laid down by the 1905 Survey Committee.

Programmes went by the board during the war and up to 1946 had not been formally re-started partly because urgent reconstruction work had to take first place in priorities, partly because post-war policy as to map series and scales had not yet been decided.

## TOURS

As explained under *Conferences*, tours of inspection were much curtailed during the war owing to lack of time and the necessity for conferring rather than inspecting ; in effect, technical responsibility was much decentralized. On the other hand, there was much more movement in the Department than was normal before the war to enable personal discussions rather than correspondence to be carried out and as a result to get quicker action.

The Surveyor General made a point of visiting Dehra Dūn once a month mainly to confer and deal with problems on the spot ; he "inspected" little.

He also made a point of visiting the training area at Abbottābād two or three times a year the main object ( apart from dealing with problems on the spot ) being to have a first hand idea of standards of personnel and whether training methods were suited to army needs.

The annual round-the-Department-tour of the Surveyor General was completely dropped ; Calcutta was not visited by him after the Map Publication Circle moved to Dehra Dūn and South India not at all after 1940.

2. Movement was mainly by rail ; air travel was used a little particularly on the military side, road travel very little after petrol rationing came in. With some difficulty, the Surveyor General obtained authority to make his monthly visits to Dehra Dūn by car ; an easy four hours by road, an uncomfortable twelve or more hours journey by train.

A curious kink in the petrol rationing system was that a certain make of car was "required" to do 20 miles per gallon ; it could not do so, however well "tuned". There was therefore no alternative but to ( perhaps one might say ) "distort" the mileage it was expected to travel during a journey to Dehra Dūn and back, to obtain sufficient supplementary coupons.

## TRADE PAY

Trade pay as such was not granted in the Survey of India ( except a small allowance to air surveyors ) nor in the military survey service at the outset. It was commonly granted in the army for other skilled trades but for surveyors only in the Sappers and Miners and one or two other services.

These services were having much difficulty in obtaining suitable men, as began to be the case with the Survey of India ; survey training takes a long time and men were likely to get advancement more quickly elsewhere.

2. In 1942, the Surveyor General was invited to attend a conference in the Defence Department with a view to co-ordinating trade pay for surveyors in all services and to fixing rates that would attract sufficient recruits of the right type.

There was some difficulty in arriving at a solution because of the great difference in the various services in the qualifications required and in the duties of a "surveyor". In the end, a sufficiently elastic basic scale was fixed and from its introduction our recruitment and volunteering situation greatly improved; before its introduction, personnel in the military survey units, if on military rates of pay, received pay of rank only and it was seldom therefore that military rates were more advantageous to tradesmen than civil rates plus allowances ( Table B ); after its introduction, military rates were frequently considerably the better.

3. In fitting the rates to survey service personnel, the only possible method was to allot the approved grade rates to Survey of India *ranks* coupled with length of service in a rank because there was no possibility of carrying out trade tests, as such, for men already in military employ nor is it easy to do so at any time for topographical surveyors—their "trade test" is in fact the actual map they make over say a five months field season. As, however, Survey of India personnel were promoted in civil rank according to the actual results they produced, the method eventually employed seemed logical and seemed to work fairly both within the survey service itself and as between the survey and other services using surveyors.

The Rates are given in Table B. See also *Terms of Service*.

## TRAINING

Before the war, the total strength of the Survey of India in officers and other ranks, *excluding* inferior ( now class IV ) service personnel was roughly 1,400; in 1945 the strength was roughly 2,850 so that about 1,450 officers and men had been trained or were under training when the war ended, *plus* a considerable number recruited to fill vacancies caused by superannuations.

These officers and men all had to be trained from "scratch"; that is, in the fundamentals of survey, drawing or map publication work as the case might be and practically all had also to be trained in the requirements of military survey; though only about 720 were in military employ when the war ended, many more had been in the army and returned to civil for various reasons—sickness, for use as instructors or to augment shortages in the Department ( see *Base Organization* ) and so on.

Besides this fundamental training, refresher and other courses had to be undertaken for both Survey of India and non-Survey of India personnel and very full training was given to 4 officers from the Malayan Survey Department, a number of Afghān officers and some Chinese officers. See *Malaya, Afghānistān, China*.

After map publication, training was the heaviest task of the Department throughout the war.

2. Except in air survey and military survey, training before the war had been practically completely decentralized to units ; there were no training parties except No. 18 ( the Air Survey Party ) and no schools except a small officers' school at Dehra Dūn formed from time to time to teach fundamentals to a very small number of recruits to the Class II and Upper Subordinate Services. Military survey training was also decentralized between "A" and "E" Companies and No. 18 Party except for the bigger training exercises when representatives from all three units and also other volunteers for active service were collected together ; for the 1938 and 1939 comprehensive exercises they were assembled at Risālpur. See *Frontier Circle* and Chapters I, 15, and V, 57.

This system was continued during the early part of the war except that comprehensive and intensified war triangulation training was carried out in the early months of 1940 in the N.W. Frontier Province ( see *Triangulation* ) and that the curriculum for the school at Dehra Dūn was expanded to cater for Class I Officers and the school itself expanded in size. See Chapter VIII, 105–107.

3. Original military commitments were to supply and maintain two Field Survey Headquarters and two Companies, besides a Survey Depot.

By 1941, three headquarters and three companies had been raised and the equivalent of five or six more promised ; by this time also, field work had practically ceased in the topographical circles and with it facilities for training personnel. It therefore became necessary to establish special training units for field survey ; this was done by the formation of the Surveyors' Training Party ( No. 2 Party ) with headquarters at Abbottābād and the expansion of the small Dehra Dūn school into an Officers' Training Party ( No. 4 Party ) which worked for some time about Dehra Dūn and Chakrāta and then followed No. 2 to the Abbottābād area.

More detail is given under the heading *Training Parties*.

4. No. 2 Party catered entirely for Lower Subordinate field staff ( plane-tablers, levellers, traversers, etc. ), No. 4 Party entirely for Class I, Class II, Upper Subordinate Officers and Topographical Assistants—those who were required to have a sufficient knowledge of plane-tabling but who also had to learn all branches of theodolite work, including astronomical observations, and computations. In both units, tests for stereoscopic vision were made and those possessing it passed on to No. 18 ( Air Survey ) Party for training in that branch, after completing their field courses, or in interruption of them, depending on the head of work in No. 18 Party.

Because the Roorkee course had been stopped ( see *Soldier Surveyors* ) No. 2 Party had also to devote some of its syllabus to military route sketching, map reading, etc.

Only such drawing training as was necessary to enable personnel to plane-table legibly was given in these units. They concentrated on field work and, in the case of No. 4 Party, field computations.

5. At the outset, about 18 months training was given to plane-tablers and this produced some very well trained men; in peace time, three to five years was necessary to produce a good plane-tableter, but this was because the field seasons of about five months duration were alternated with the recess (drawing) and leave season; the continuous field season during war training resulted in much quicker training but did of course leave much to be desired in fair-drawing standards. The standard of fair-drawing lowered very considerably among surveyors trained during the war. It will still take about five years to produce one who is both a good plane-tableter and good draftsman.

6. Later on, as more units were formed and maintenance became heavier, the plane-tabling course had to be reduced to eight months, followed by the air course and leave, the whole taking about a year. When time permitted, further field training was given after the year; men were, however, considered to be sufficiently trained to join military units at the end of one year, if necessary. The standard was, of course, correspondingly lowered.

Officers were started off, like plane-tablers, with drawing instruction and practice which in their case included construction of scales, etc., followed by large scale plane-tabling (100 feet to an inch), which took about a month. Another month on plane-tabling on smaller scales like 1/25,000 and 1-inch was about all that could be afforded, the remainder of their time—varying according to individual ability and the reinforcement situation—being devoted to theodolite and computational work, base measurement (*Hunter Short Base*) and military survey exercises and schemes such as the rapid extension of a triangulation system from a short base, the provision of trig. points to control an air map, etc.

7. In air survey, our aim was to teach the fundamentals of the radial line method. Once these were mastered, a trainee possessing the necessary ability could fairly easily progress farther into more difficult subjects such as the plumb point method, the use of obliques, the stereocomparator and so on.

In carrying out actual practical work, stress was given to methods currently in use in the military survey units.

Officers and surveyors were kept under air training as long as they could be spared and there was room to accommodate them in No. 18 Party. The "course" ran from six weeks or so, to as much as three or four months; naturally, those who stayed longest became the best air surveyors. It was impossible to adhere to rigid length courses because of the fluctuating requirements of the military survey service, depending on the operational situation.

In the case of non-Survey of India courses, however, like the intelligence courses, rigid syllabuses were adhered to. See *Air Survey Party*.

8. Officers and men learnt a bit more about drawing while doing their air courses. Some who showed no ability in field work were tried on drawing in the Frontier Circle or elsewhere, a number of such men being utilized as draftsmen in military formations for which they were satisfactory even though not up to the standard required for fair drawing in the survey services.

Draftsmen as such were recruited mainly in the Eastern Circle at Dehra Dūn, the "drawing circle" of the Department for most of the war. All offices, however, recruited and trained any suitable men that could be picked up locally.

After about a month, it was fairly evident whether a recruit would ever become a passable draftsman; if so, he was put on simple drawing work, if not, he was discharged. By the end of about six months training, the average recruit got quite fairly good at simple work, by the end of a year he was ready to undertake more complicated work such as drawing symbols, etc.

As far as possible, draftsmen and negative retouchers (photo-writers) were interchanged at Dehra Dūn; the two trades require much the same technique and having men interchangeable did much to relieve negative retouching (duffing) bottlenecks and vice versa, see *Map Policy*.

An experiment not very successful, was in training draftsmen in air survey work: results bore out our pre-war view that to be a good air surveyor one must first learn to be a reasonably proficient plane-tableer.

9. Map publication personnel were also recruited locally by the various offices as well as, to some extent, centrally for training in Calcutta before the move of the main publication office to Hāthibarkala and in Hāthibarkala after it.

Training in the higher branches of the photo-lithographic art, however, takes a very long time; for instance, a machine-minder is normally apprenticed for seven years. The necessity for attaching British technicians to the Survey of India followed and is discussed in more detail under *Cadres* and *Map Publication*. These officers and B.O.R.'s besides performing the more highly skilled operations in our publication plants also trained our Indian machine, photographic, etc., crews to take over from them. Our own officers too carried out a great deal of training but in the case of the more senior, were heavily engaged on organizational and administrative work.

The Survey of India possessed no personnel fully *au fait* with modern automatic machinery, for we had no such machinery before the war.

10. The training of clerical staff was a problem. Like all government departments, the Survey of India was short of trained staff throughout; so too was the military survey service. It is not

easy to organize a "Clerk's Training School" and its efficacy would be doubtful; we had to make the best of the peace-time system of giving recruits odd jobs, gradually building up their responsibilities as they showed their capability of handling them. There was no serious breakdown either in the civil or military services for which a very large share of the credit is due to Rai Bahadur Diwan Chand Verma, M.B.E. See *Surveyor General's Office*.

11. Advanced training in theodolite work and to some extent in plane-tableing was carried out in the Hazāra and later Kulu Settlement Detachments, which gave fine scope for this work, see *Hazāra, Kulu*. Though field computations were taught in No. 4 Party, some computers were trained from the outset in the War Research Institute and all who were to do advanced work were given additional training there. Computing machines were carried by the military field units and preliminary training in their use given in No. 4 Party; considerable practice is, however, necessary for real facility in using these machines and this was usually acquired at Dehra Dūn, or on actual productive work.

12. Inferior servants (khalāsīs) were trained in their chaining, heliotroping and similar duties in the unit in which they were recruited, as in the past; in the case of direct recruited I.O.R.'s, the Survey Depot performed this function.

13. A general idea of the number of Survey of India trainees passing through the various establishments during the war is given in paragraph 1 above.

14. After VJ Day, Nos. 2 and 4 Parties switched from military survey training to training in the special duties required for the reconstruction projects of highest priority and to research in the methods most suitable to carry out these projects most expeditiously and with minimum expense. Officers and men who had received only brief war training were required to attend refresher training in these units and to learn the special methods suitable for reconstruction.

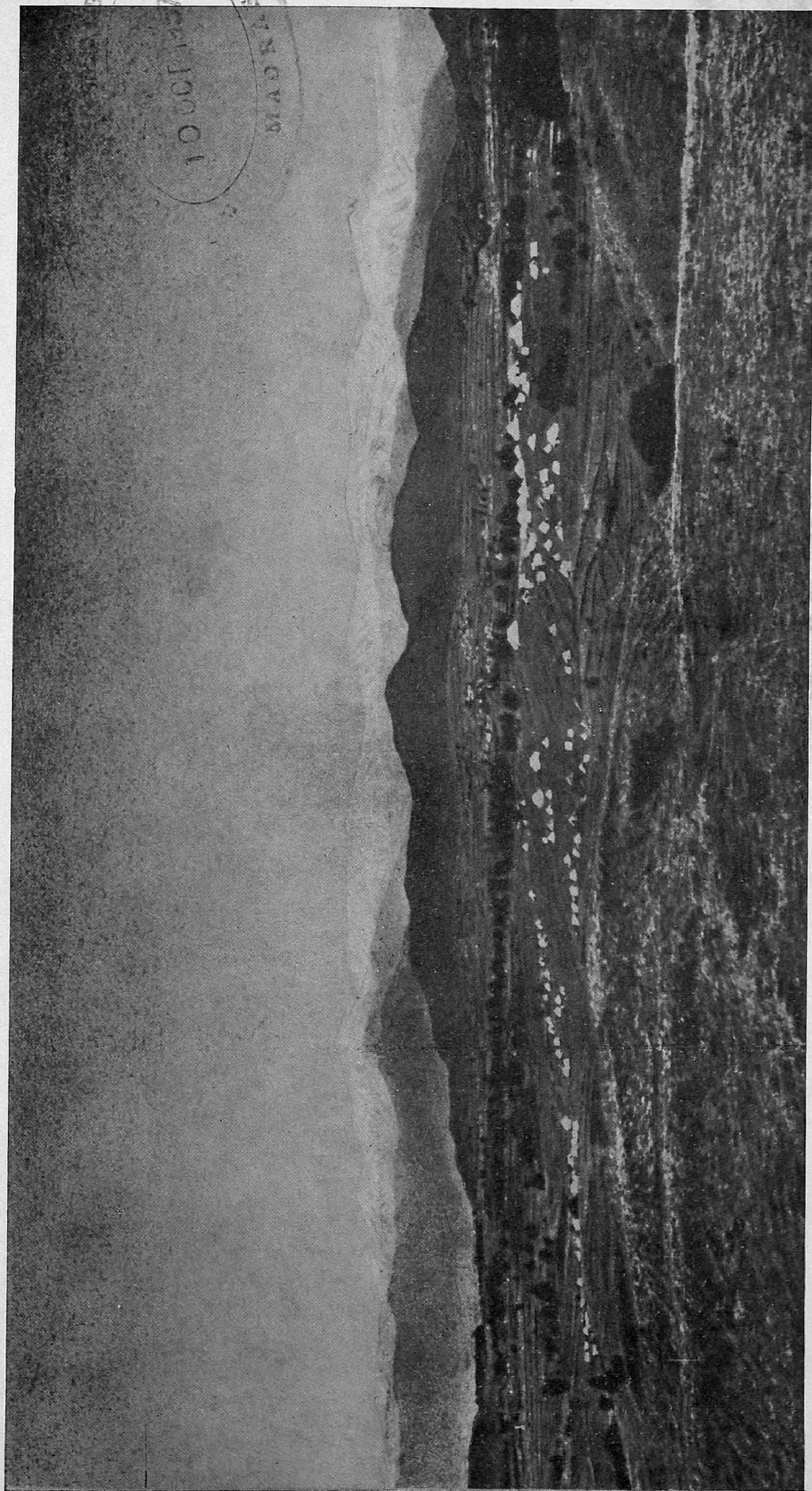
No. 18 (Air Survey) Party similarly switched from methods suited to war needs to those more suited to reconstruction needs, while at the same time taking on more productive work than had been possible during the heavy training activities of the war.

## TRAINING PARTIES

The work of No. 18 (Air Survey Party) has been outlined under that heading. Training in general has been outlined under *Training*.

2. It has been explained under *Training* that plane-tableers were normally trained in the various field units of the Department,





TRAINING CAMP NO. 4 SURVEY PARTY (FRONTIER CIRCLE).

Photo J. C. Berry.

in peace. The cessation of field work in 1941 removed this facility ; at the same time it was evident that large numbers of plane-tableers would have to be recruited and trained quickly if we were to fulfil our new commitments of eight or more field survey headquarters and seven companies *plus* various smaller units, and maintain them in the field.

Civilian recruits had become increasingly hard to get, the army tapping the same recruiting sources as ourselves ; furthermore, they took much longer to train than soldiers because the latter were normally fitter physically and had received education in the army which most of our civilian recruits lacked. It was therefore arranged with the army to pool resources and to call for a batch of 100 volunteers for survey work, to be trained in a specially formed unit of the Survey of India and at the same time it was decided to discontinue the Roorkee surveyors course, relying on the Survey of India for all topographical, sketching and map reading training. See *Soldier Surveyors*.

3. While the call for volunteers was going the round of India the Survey of India set about forming this training party, No. 2 Party, at Abbottābād ; this place was selected because of its all-year training climate ( either in its immediate vicinity or 2,000 feet lower down in the vicinity of Haveliān or Haripur ), its proximity to Murree where air survey training would continue to be carried out and the fact that it was a considerable military station where the 100 soldiers, coming from nearly as many different battalions, etc., could be accommodated and administered.

Because speed was essential, the proportion of instructors and supervising staff to trainees was made very high. Only 4 or 5 trainees were allotted to one surveyor-instructor, about 4 instructors to one Upper Subordinate Officer and only 2 or 3 Upper Subordinates to one Class II Officer ; the unit was formed by and placed under the command of Mr. Mahadevan Mudaliar ( later M.B.E. ) an officer of very wide survey experience who had just retired from the Department and volunteered to be re-employed.

By the time soldiers came to report at Abbottābād the unit was ready to receive them and was established in very satisfactory hired offices there. In the event, only about 70 soldiers turned up, so that the proportion of instructors to trainees was even higher than at first envisaged. This paid handsome dividends for within a year we had over 50 good plane-tableers and at the end of 18 months when most of them left the party, some were really excellent.

4. As the war progressed, the proportion of instructors to trainees had to be reduced due to so many of our best men being in military employ and the older men, who started the party, becoming too old for active field work. Coupled with the reduction in the length of the course to 8 months, the standard naturally dropped considerably ; not so much as might have been expected, however, for by this time a routine had been developed and the

instructors and officers of the party had become much more skilful at teaching.

Towards the end of the war, we had to call upon the army to let us have back three good instructors, having ourselves run dry.

5. About one quarter of each batch of trainees was kept in headquarters at a time, doing drawing work ; the remainder lived in camp learning plane-tableing, during the summer between Abbot-tābād and Mānsehra and vicinity, during the winter in the hilly ground west of Haripur.

6. Administration of men from so many different military units caused some difficulty, but we were greatly helped by the local military authorities who did all possible to simplify ration, etc., procedure and to deal with disciplinary matters in which our own officers, being civilians, had no powers.

For the latter part of the war, however, a small administration section ( military ) was attached to the party ; this was commanded by a Survey of India officer in military employ who besides running the military administration also took charge of one of the training camps.

7. No. 4 ( Officers' Training ) Party had originally been the Dehra Dūn Training School and followed No. 2 Party to the Abbot-tābād area in 1942 ; the reasons for sending it to Abbottābād were the same as those affecting No. 2 Party. See Chapter VII, 97.

This unit, however, remained in camp throughout the year, near Mānsehra during the summer, near Haveliān during the winter. A stores-cum-office hut was built at each camp in 1944, all work up to then being done under canvas. Living under canvas was of considerable value to many of our young recruit officers who had previously never lived in a tent and had no idea of camp life at all ; this was regarded as part of their training. A mess similar to army officers' messes was formed with army help and this too proved very valuable from the training point of view.

Cricket, hockey and football were encouraged and the party played a number of games each year against local military and other sides. No. 2 Party had less opportunity, for these games, for its personnel spent a considerable proportion of their time in relatively isolated small camps ; it too participated in some of the games, however.

8. The composition of the trainees in No.4 Party was mainly Class II probationer officers and Topographical Assistants. There were always a number of military officers under training as well, however, and for a part of the time up to 14 officers of the Afghān army and one or two officers of the Chinese army. All mixed in together and got along very well together. Social amenities were provided by dances and other entertainments at the Abbottābād Club and elsewhere in Abbottābād. Motor transport was sufficient to permit movement to and from Abbottābād.

Ration arrangements presented some difficulties with so mixed a collection of trainees, but with the help of the army authorities and later No. 2 Party's military administrative section, these were successfully overcome, as also the tentage problem ; Survey of India tents were mainly fairly old and new ones were not easy to get, but army assistance in this matter too solved our problems, as with motor transport.

9. With the cessation of hostilities, both 2 and 4 Parties switched over to training for reconstruction projects and research in methods suited to them, the latter party moving from its camp at Mānsehra to buildings in Kākul in the neighbourhood of which most of this training was carried out.

As has been mentioned under *Projects*, parties for reconstruction work were formed here and then transferred to their respective areas in southern and eastern India.

10. As in the case of No. 2 Party, the proportion of instructors to trainees was kept high so that considerable individual attention could be given to each trainee.

The average strength of the parties was :—

	No. 2 Party	No. 4 Party
Staff and instructors	12	12
<i>Trainees :</i>		
Surveyors and other L.S.S.	100	60
Military Officers	15	20
Class II Officers	..	15
Topographical Assistants	..	30

11. Khalāsīs for the training parties were found partly from experienced Survey of India personnel and partly by recruitment of local Hazāra District men. A considerable proportion of the former came from Bihār and were not entirely happy in north-west India but our usual sources of supply in the Punjab and Garhwāl had been heavily tapped for the army and few men from those parts were forthcoming.

12. The Hazāra Detachment also had its headquarters in Abbottābād which was convenient in carrying out advanced triangulation training, see *Hazāra*.

## TRAINING SCHOOL

The small officers' training school at Dehra Dūn was taken over by a military officer and considerably expanded in 1941 and continued to train officers in that neighbourhood and about Chakrāta till moved, as No. 4 Party, to Abbottābād in 1942. See *Training Parties*.

## TRAINING SYLLABUSES

Training in general is outlined under head *Training*, the work of various parties under *Training Parties* and *Air Survey Party*.

Syllabuses varied with the situation at the time, having to be shortened towards the end of the war as maintenance of personnel became heavy. Those for training survey personnel were considerably different from those required by intelligence and similar courses.

Syllabuses crystallized towards the end of the war but also became very detailed and a complete record of them would be of little value.

## TRANSPORT

At the outset of the war, motor transport in the Survey of India consisted of two old 30-cwt. lorries and a tractor-trailer to carry one rotary offset printing machine. The Department relied in the field on hired cart, pack or coolie transport except in Baluchistān and Sind where the two lorries had been in use for ferrying over long road distances, camels being used for camp transport.

War establishment tables allowed for motor transport for field survey headquarters and companies, but none was held on charge.

The idea of using cycle squads for quick correction surveys had been mooted but not developed.

We possessed three reasonably well qualified M.T. drivers, two of whom had been khalāsīs.

2. A number of vehicles were purchased during the war, including two station wagons; some 60 more, weapon carriers and jeeps, were on order at the end of the war for reconstruction works.

Except for the few purchased we relied very largely on the army for M.T. during the war; vehicles of various types were loaned both by the army in India and by the War Office, the latter being vehicles originally intended for military survey units for carrying printing machinery but which had been superseded by later types. They were invaluable for moving heavy machinery in the new Hāthibarkala offices. See *Hāthibarkala, Stores*.

Drivers were found from various sources, some army, some civilians.

3. Petrol rationing caused us some difficulty; it was not always easy to convince the authorities that the Survey of India was employed on essential military work and for this reason it was sometimes very convenient to have the military vehicles available. Similar considerations affected servicing the vehicles.

Travelling by private car became very difficult indeed and this handicapped us to some extent, for we had insufficient Government owned passenger vehicles for touring purposes; to utilize heavy lorries for this purpose was not only uncomfortable and slow but very wasteful. See *Rations*.

4. Maps were usually sent from Dehra Dūn to the Central Map Depot in Delhi by lorry or truck ; otherwise, transport was mainly by rail except in the training areas about Abbottābād.

Air transport was little used by the Survey of India except in our attempt to stock Burma up with maps before the Japanese invasion.

## TRAVELLING ALLOWANCE

Rules for travelling and daily allowances differed in the army and in the Department ; this caused some embarrassment in dealing with mobilization and demobilization, mentioned under *Demobilization* and also in granting daily allowance to military officers attached to the Survey of India. This, however, was eased by the Surveyor General being authorized to certify military daily allowance on much the same basis as the civil allowances. This was very necessary in the training parties.

## TRAVERSE

Theodolite traversing was much used in the Survey of India in flat areas and all officers and a considerable number of lower subordinates were familiar with it, at least with a vernier theodolite and chain measurement of distance. Subtense methods were also used for measuring distance, but tacheometer (stadia) methods were seldom used.

During the war traversing was taught all trainees in No. 4 Party see *Training Parties* and some practical experience was also gained in the Hazāra and Kulu Detachments by most of these trainees. Much traversing was carried out by the Cantonment Party in Assam and elsewhere ( see *Assam and Cantonment Party* ), as well as by military units.

2. For accurate long distance traverses, the *Hunter Short Base* either in full, or in short sections, was used as the "subtense bar" ; this gave approximately a 90 yards "bar" fitted with suitable observing targets at each end and a very high standard of traverse accuracy of the order of secondary triangulation. This method was used for crossing a portion of the Lūt Desert, in the triangulation connection between 'Irāq and India, see *Baluchistān*.

It was also proposed to use this method, with a base high enough to over-top high crops, in some of the reconstruction surveys.

3. Plane-tabling traverse methods were known to all Survey of India plane-tablers and were taught all officers and men in the training parties, including the method of adjustment normally used.

Skill in plane-table traversing is nevertheless acquired only with a lot of experience and for those who had to plane-table in very enclosed country, further training in its tricks was necessary. In very heavy jungle, "sound-traversing" sometimes has to be used and this too required a lot of training. Such specialized training was not given in the training parties.



4. Details about traversing will be found in the Survey of India Topographical Handbook Chapters IV, V and VIII and in brief in Part XI of the Survey Service Pocket Book.

## TRIANGULATION

India had been covered with a network of very high precision triangulation, on which topographical triangulation was based ; no high precision triangulation was in progress when war broke out though a high precision traverse across southern Bengal to join two triangulation series had been mooted. Topographical triangulation was continued as long as field work was continued, but no higher class work was undertaken in India during the war. See *Baluchistān, Afghānistān*.

Burma had also been covered by the Indian high precision triangulation as well as topographical for the control of its maps ; the records of the former were at Dehra Dūn, the latter unfortunately in Burma and were captured or destroyed ; they could not be found after the war ( see *Burma* ) and the country will mostly have to be re-triangulated.

India and Burma triangulation were based on the same ( the Everest ) spheroids, that to the east in Siam, to the south in Malaya and to the west in 'Irāq and western Irān on different spheroids. There was consequently difficulty at the junctions of these various triangulations. See *Spheroids* and *Baluchistān*.

2. Except in the Hazāra and Kulu Detachments and to a smaller extent in a few other irrigation and similar surveys, little triangulation other than for training purposes was done in India after regular field work ceased. It has been explained under *Hazāra* that this detachment, and later the Kulu Detachment, was used for advanced training in this subject and that a special Lambert grid had been calculated for Hazāra District to enable this training to be carried out in the same terms and by the same methods as would be used in military surveys.

A considerable amount of triangulation work was done in 'Irāq/Irān by military survey units formed by the Survey of India, see *'Irāq*.

3. One of the biggest problems envisaged in our pre-war military training was the provision of trig. control of sufficient quality and quantity, and in sufficient time, to enable an accurate map of enemy country to be made from air photographs. Much of our training had been directed towards this end and many exercises in full or in skeleton carried out in north-west India, several in co-operation with the R.A. Survey Section. Major exercises in 1938 and 1939 developed this theme, and in 1940 classes for training in rapid triangulation were held in the N.W. Frontier Province initiated by Major G. Bomford, R.E. ; a considerable number of officers attended these classes, including our Mathematical Adviser, Mr. B. L. Gulatee, M.A. ( CANTAB. ).

Methods developed are described in Part XI of the Survey Service Pocket Book ; normal topographical triangulation procedure is described in Chapter III of the Topographical Handbook, earlier war methods in Chapter VIII of that handbook.

4. Thereafter, triangulation training ( following the methods developed in 1938-40 ) was carried out in the Training School at Dehra Dūn, later No. 4 Party at Abbottābād, see *Training*, and *Training Parties*.

A cardinal principle followed in this training and in the initiation of all small triangulations like those required for reconstruction surveys was to obtain geographical position from a well fixed primary triangulation point ( or other "best available" ), scale from a *Hunter Short Base* extension and direction from an astronomical azimuth, retaining scale and direction by check bases and astronomical azimuths at intervals with an overall check by closing on another primary or "best available" point. Chains of triangulation were preferred to complicated figures such as had sometimes been the practice in our peace-time topographical triangulation. This paid off in saving of time both in reconnaissance and observation. The principle was used in both Hazāra and Kulu surveys, *chāndas* ( mark-stones ) being intersected from the appropriate chain ; where observed from more than one chain they formed points of check and adjustment as between chains.

5. Peace-time triangulation was normally computed in spherical terms, resulting co-ordinates being recorded by latitude and longitude. Cadastral surveys were normally executed in rectangular terms, usually on the Cassini projection ; the Lambert conical orthomorphic projection was, however, used for the Hazāra and Kulu settlement surveys so as to provide practice in war survey methods. All war surveys were executed in terms of the latter projection, for which complete sets of computation forms had been designed for use either with logarithms or computing machine and slide-rule.

Where points in spherical terms were required in Lambert Grid terms, conversion had to be carried out ; this is a somewhat tedious process but for a considerable part of India "Grid Pamphlets" existed, having been computed and published before the war ; during the war, many thousands of points ex-India were converted by the Computing Office at Dehra Dūn.

The values of points obtained from surveys executed in rectangular terms on the Lambert projection of course required no conversion, being already in "grid terms". This is the advantage of executing surveys in grid terms, but there are offsetting disadvantages, see *Grids, Projections*.

6. Plane-tabling is, of course, a form of graphic triangulation using wholly graphic methods for resection and intersection whereas instrumental triangulation may use wholly computational methods, or partly computational, partly graphic ; the "semi-graphic"



resection computation was largely used in our rapid triangulations in cases where resections ( to be avoided ) had to be used.

Surveyors were not trained to triangulate on the plane-table, except as part of the plane-tabling routine, but many good surveyors have developed the art highly and it was used to supplement instrumental triangulation in hasty surveys. It can be very accurate with a skilled operator.

## TRIG. DATA AND PAMPHLETS

See *Triangulation, Computations, Grids, War Research Institute.*

## TUNGABHADRA

The Tungabhadra River is a major tributary of the Kistna and is the boundary between Hyderābād State and Madras Presidency for a good deal of its length, about latitude 15° N.

Like the Kosi and Tista projects, this Tungabhadra project is designed to combine flood control, irrigation and hydro-electric power requirements ; a considerable amount of preliminary and planning work was done during 1945-46 and the project was a considerable factor in causing the old Southern Circle of the Survey of India to be re-formed. See *Organization.*

## TYPE

It was Survey of India practice to type names on its maps, using the "Southampton Pattern" hand-typing machine. Though a good typer could deal with a considerable number of names per hour, this method was of course not nearly so quick as hand lettering provided good men could be found for the latter purpose. During the war therefore we gave a lot of attention to training draftsmen in hand lettering, so as to speed up the application of names to maps in a form at least good enough to be readily legible.

When there was time, the type machine was used ; some British made type remained from pre-war days, but much of the type used during the war was cast in our own casting machine, see *Monotype Machine* and *Letter Press Printing.*

## UNIFORM

The question whether or not military officers in civil ( Survey of India ) employ should or should not wear military uniform was a somewhat hotly debated one from time to time. See *Security* and Chapter VI, 83.

## UPPER SUBORDINATE SERVICE

The U.S.S. was a non-gazetted service that was mainly supervisory though its personnel were frequently required to perform

individual tasks beyond the normal capability of lower subordinates ; many of its younger members were university graduates and some might equally well have been in the Class II Service but for the fact that recruitment to Class II and U.S.S. occurred in alternate years and a graduate who would be over age for the next Class II recruitment had to accept U.S.S. if he wished to get into the Department. Some of the best of these officers were promoted to Class II during the war.

Many of the more senior members of this service were not graduates or had been promoted from the Lower Subordinate Service.

2. The pay of the U.S.S. was low relative to the qualifications of many of the men in it and it was very difficult during the war to obtain anyone on such pay ; recruitment was therefore stopped and men taken in on a temporary basis as *Temporary Computers* or *Topographical Assistants* ; this enabled their pay rates to be controlled by the Surveyor General as necessary.

Men of this type were essential both to war work and reconstruction work ; to use Class II officers on individual works was extravagant but on the other hand lower subordinates were not educationally up to triangulation, astronomical, computational and similar tasks.

3. The corresponding map publication and drawing services were known as "Division II".

## VARIATION ( MAGNETIC )

This term was used on later maps to mean "declination". The reason is explained under the heading *Magnetic Work*.

## VERIFICATION SURVEY

This term has been used in various places particularly in connection with Burma and the north-west of India.

It was Survey of India practice to obtain information for the improvement and bringing up to date of its maps from the various Provincial and other Local Governments, the Public Works Departments, both Central and Provincial, the Railways, the Geological Survey of India, etc. In most cases, the information supplied was of too general a nature to permit its inclusion in a new edition of the map concerned without first being checked and precisely located on the ground by a skilled surveyor. The process of doing this check and accurate location was called "verification survey"; the surveyor also of course picked up any information that came to his attention during the course of this work but he did *not* make any attempt at general *revision* of the area under verification—merely the specific items that were brought to his attention by his verification survey orders. Revision survey is quite different and implies checking every item that appears on any given map ; it is

consequently very much slower than verification survey and, in a sense, involves much waste effort for more often than not the great majority of items are correct at the outset.

## VICEROY'S COMMISSIONED OFFICERS (V.C.O.'S)

Officers of the Upper Subordinate Service of the Survey of India were granted Viceroy's commissions on being mobilized and also the more senior of the Lower Subordinate Service, as well as Temporary Computers and Topographical Assistants.

More junior members of the Lower Subordinate Service were havildars; the military ranks of naik and below were reserved for the Inferior Service of the Survey of India.

2. A V.C.O. Cadre was also formed in the Survey of India to enable to a limited number who were in the army to be utilized temporarily in the civil Department when necessary. See *Cadres*.

3. A Table of military ranks authorized for Survey of India personnel on mobilization is given in Table B.

## VISITORS FROM OVERSEAS

Visitors to the Survey of India during the course of the war included Brigadier M. Hotine, C.B.E., Director of Military Survey, War Office, Brigadier R. L. Brown, C.B.E., Director of Survey, Mid-east, Mr. W. F. N. Bridges, Surveyor General of Malaya, Colonel J. S. E. Bradford, O.B.E., D.D. Svy., ALF SEA (from Southern Rhodesia), Lt.-Colonel F. O. Metford, M.B.E., from Mid-east, Major Esebach, C.E., Comdg. 653 Topo. Battalion, U.S. Army, Lt.-Colonel G. S. Andrews, M.B.E., Royal Canadian Engineers.

## VOLUNTEERS FOR MILITARY SERVICE

Except for its cadre of military officers and some of its soldier surveyors, no personnel of the Survey of India could be ordered on military service, the Department relying wholly on the volunteering system. In the later stages of the war, however, the majority of new recruited temporary personnel were required to volunteer for the Supplementary Survey Reserve before being accepted, because it would have been a waste of precious training time to train up temporary men unwilling to volunteer for military service. Once terms of service were made adequate there was no lack of volunteers from the Department.

See *Reserves*.

2. At the outset, both officers and men were a little reluctant to volunteer because terms of service were not clear, see *Terms of Service*. As soon as terms were clarified and particularly after trade pay was introduced, there was no lack of suitable volunteers

## WAR ACTIVITIES REPORT

This report was designed to give the Government of India a very brief annual picture of the work of the Survey of India ; its distribution except to the Government of India was almost entirely military.

See *Reports*.

## WAR ALLOWANCE

During the latter part of the war, a "war allowance" was granted to all personnel in civil employ on pay below a certain amount. Directors of the Survey of India were not eligible for this allowance which resulted in some cases of deputy directors, who were granted an allowance for their extra responsibility as such, receiving higher total emoluments than the minimum pay of a director. It would have been preferable, in the case of military officers, to allocate temporary military ranks to civil posts which would have avoided this and similar anomalies, see *Promotions* 2, 3.

## WAR DIARIES

War diaries were not maintained by the Survey of India. The monthly reports from directors to the Surveyor General, from which the War Activities report was compiled, served a similar purpose. See *Reports*.

## WAR EQUIPMENT TABLES

These tables, which serve the same purpose as the British "G. 1098", were being recast when the war started in the light of the 1938 and 1939 military survey exercises ; they were completed in typescript and duplicated in time to function for the formation of the first units for overseas. See *War Establishments*.

An outline of major items of equipment as then decided was included in Part II of the Survey Service Pocket Book, 1941. See Table M.

2. Instruments and equipment of Survey of India supply for two companies and headquarters had been collected at Risālpur, based on old tables, by the early stages of the war. This had to be modified and amplified in the light of the recast tables and equipment of Ordnance supply collected when units began to be formed.

3. With the formation of the Survey of India Stores Organization, stocks of instruments and equipment of non-Ordnances supply were collected and stored for issue to units on formation and for their maintenance. The Tables were modified from time to time according to changing requirements and according to availability of instruments, paper, chemicals, inks, etc.

After the formation of the Geographical Section, General Staff, the Survey of India was not concerned with the Tables, except to supply their requirements through its *Stores Organization*.

4. Articles of Ordnance supply were dealt with under normal military procedure.

## WAR ESTABLISHMENTS

Like the War Equipment Tables these were in the melting pot at the end of 1939 as the result of the comprehensive 1938 and 1939 military survey exercises. Outline establishments as decided in 1940 were published in Part II of the Survey Service Pocket Book, see Table M. In common with most military establishments, these were changed from time to time and new units added to meet changing circumstances.

They were originally designed on the basis of semi-independent *sub-units* rather than units in order to retain as much as possible of the flexibility of the Survey of India non-rigid party system. This was done with the concurrence of the General Staff and Q.M.G.'s and Ordnance Branches.

See *Military Survey Units* and *Military Organization*.

2. Special establishments to suit Burma conditions were drawn up and approved by Army Headquarters, Burma in 1941 and No. 6 Company and Headquarters mobilized on these, see *Burma* and *Burma Survey Party*.

Indian establishments had been drawn up on the basis of war on the N.W. Frontier and were not very suitable for Burma or perhaps for other battle areas.

3. The Survey of India ceased to be concerned with war establishments—except to supply the men—after the formation of the *Geographical Section, General Staff*.

4. In the original arrangement of war establishments, much thought had been given to how to fill vacancies, in allotting ranks to the various posts; they had almost to be fitted to individuals on the volunteer list. The war system of acting and temporary ranks very largely removed this difficulty though creating others, see *Promotions*.

## WAR HISTORY

See *History*.

## WAR LEAVE

This has been dealt with under *Leave*. It produced some administrative problems, along with *Lilop*.

## WAR RESEARCH PAMPHLETS

The *War Survey Research Institute*, described in the heading that follows, besides taking over the scientific work normally carried out by the Geodetic Branch did a considerable amount of

research work on methods for astronomical observations, base measurement, etc. The results of this research and also of certain special tasks carried out by the Institute were published in a series of pamphlets called War Research Pamphlets.

These were printed in the letterpress section of the Geodetic Branch at Dehra Dūn, and are as follows :—

*War Research Series Pamphlets.*

- Pamphlet No. 1. Part I. Star Almanac, Ephemeral Tables 1946.  
 Supplement to No. 1, Part I. Star Almanac, Ephemeral Tables : Planets 1946.
- „ „ Part II. Star Almanac, Permanent Tables, Second Edition, 1945.
- „ No. 2. Part I. Circum-Meridian observations for Longitude ( time ) and azimuth, also for Latitude.  
 Part II. Rapid Astrofix from Circum-Meridian observations by J. de Graaff Hunter, C.I.E., sc.D., F.R.S., 1944.
- „ No. 3. Astro-Clinometer, by Major E. H. Thompson, R.E., 1944.
- „ No. 4. Notes on the use of the Bubble Sextant Mk. IX for Ground observations, by Col. D. R. Crone, O.B.E., 1944.
- „ No. 5. Daylight Astro-Fixes, by Col. D. R. Crone, O.B.E., 1944.
- „ No. 6. Magnetic Anomalies ( India and Burma ), 1944.
- „ No. 7. Astrofix By Two Ex-Meridian Stars. Third Edition 1945, by J. de Graaff Hunter, C.I.E., sc.D., F.R.S.
- „ No. 8. Half-hour Astrofix By Two Circum-Meridian Stars. Second Edition, 1945, by J. de Graaff Hunter, C.I.E., sc.D., F.R.S., and Lieut. D. M. H. Dewar, R.E.
- „ No. 9. The Trans-Persia Triangulation 1941-44 ( linking 'Irāq and India ) by J. de Graaff Hunter, C.I.E., sc.D., F.R.S., and B. L. Gulatee, M.A. ( Cantab. ), with an Appendix "The Persia-India Connection" by Major P. A. Thomas, I.E.

## WAR SURVEY RESEARCH INSTITUTE

It has been explained under the heading *Geodetic Branch* that that Branch had in recent years become a topographical and map publication circle in addition to its scientific duties. Scientific

work was little in the early stages of the war while on the other hand map publication work and certain survey work increased hugely ; about 1943, however, demands for trig. data, tide-tables, new grid tables, conversions of trig. points from one grid to another, etc., began also to increase very greatly while publication demands continued to increase and with them and the creation of a stores organization, administrative work. See Chapter IX, 134.

The need for research in scientific methods that would be applicable to invasion forces and later to reconstruction also began to be felt.

2. At this time Dr. J. de Graaff Hunter, C.I.E., Sc. D., F.R.S., a one time Director of the Geodetic Branch, had returned to India after 18 months internment in Germany following the torpedoing of his ship while *en route* India, and was employed as Assistant Surveyor General ( Technical ) in Delhi. It was decided, in view of the factors mentioned in para 1, to dispense with the post of A.S.G. ( Technical ) and instead create a War Survey Research Institute, with Dr. Hunter as its president, which was done towards the end of 1943. Staff was insufficient to provide a full administrative office for the Institute much of whose office work had to continue to be done by the Geodetic Branch in whose compound it was found office accommodation.

3. The War Research Institute ( W.R.I. ), so abbreviated for convenience, carried out all the routine scientific work of the Department from the end of 1943 onwards taking over tide prediction and preparation of tide-tables, gravity and connected work, magnetic work, tape standardization, computational work which included the adjustment and conversion to grid terms of many thousands of points, besides preparation of a number of grid tables, in areas stretching from 'Irāq on the west to the Andaman and Nicobar Islands, Malaya, Siam, Borneo, Indo-China, Sumatra and China on the east.

A large amount of research work was also carried out in connection with astro-fixes, improvements to the Hunter Short Base Equipment, modifying the tide machine to provide certain special information required by the navy and various special tasks such as the preparation and publication of moonlight diagrams a special star almanac giving the positions of 391 stars—partly to offset the non-receipt in time of the Nautical Almanac and other similar publications.

Some of these activities have been outlined under headings like *Magnetic Work* ; some have been described in full in the various *War Research Pamphlets* detailed in the preceding heading. See also *Computations*, etc., and Chapters IX, 134, X, 156-159, XI, 160, 161.

4. Besides the existing staff, including the Computation Office, the War Research Institute was augmented by a considerable number of computers and Topographical Assistants who had a bent

for mathematics and scientific work ; it trained a number of computers required to have higher than field computation qualifications as well as certain officers in astro-fix and similar work. In the main, however, the Institute was very busy with its own research and routine problems and was not burdened with training to a greater extent than essential.

A small instrument repair shop was set up both to avoid the necessity of sending instruments to Calcutta and also to enable "mock-ups" and pilot models to be constructed. As in peace time, the Geodetic Branch workshop also carried out a considerable amount of such work.

5. Towards the end of the war, attention was being directed towards the improvement of the situation in India in respect of high precision triangulation and levelling data, not infrequently very distant from the place it was wanted for irrigation and similar schemes. The proposal was to establish at reasonably close intervals a network of monuments recording certain data upon them, and Dr. Hunter was trying to devise means of doing so reasonably cheaply.

This is outlined in more detail under the heading *AID Survey Framework*.

6. During the course of activities outlined above, the need was increasingly felt for specially recruited officers to take charge of various branches of the work. In the past, "all-round" officers had been used on these works and during the war it was extremely hard to spare them for it. It was therefore decided to change policy in this respect and try to recruit scientific officers of special qualifications and some research experience in each particular branch, as for length standardization, magnetic work and so on.

This scheme was getting under way by 1946 and concurrently a National Physical Laboratory was being created in India, the pay and status of our new officers being kept in line with those of officers proposed for that institution.

The Survey of India also agreed to act for the N.P.L. in respect of time and length standards, and to collaborate in respect of weight standards.

7. The Institute continued to function after the war, but as the "Survey Research Institute", under the Presidency of Mr. B. L. Gulatee, M.A. ( Cantab. ).

## WILD ( SWITZERLAND )

Wild theodolites were the first glass arc instruments used extensively in the Survey of India and military survey units were all equipped—at least in part with these theodolites, of the 3-inch field type.

5-inch precision theodolites were also used in the Geodetic Branch ( War Research Institute ) for high precision triangulation. See *Theodolites*.



2. The Department also possessed one Wild photo-theodolite which had been used for mountain surveys but was not required during the war.

3. A Wild A 5 autograph was acquired on loan from the Government of Afghānistān, see *Afghānistān*.

## ZEISS

A small Zeiss instrument was the first glass arc theodolite to be tried out in India, but *Wild* instruments were finally adopted for general use, until the arrival of the Tavistock. See *Theodolites*.

Zeiss (split-bubble type) levels were in extensive use both in the civil Department and in the military survey units.

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TABLE A.—*Cadres and Services*

NOTE.—The various functions are outlined in the Annotated Index.

CADRE/SERVICE	REMARKS
Survey of India—Class I.	<p>Gazetted, strength fixed by Government. Pre-war 32 military posts (on average) plus 5 reserved for promotion from Class II.</p> <p>1 Surveyor General, 4 Directors, 24 Superintendents, 8 (on average) Assistant Superintendents leave and training reserve. Pay on fixed time scale for each category.</p> <p>Numerous temporary posts (civil) during war.</p>
General Central Service— Class I.	<p>Gazetted, strength fixed by Government. Pre-war 2 posts, Mathematical Adviser and Superintendent Mathematical Instrument Office. Pay according to responsibility of posts, on time scale.</p> <p>Additional posts during war, for Stores Organization, clerical and map publication expansion.</p>
Survey of India—Class II.	<p>Gazetted, strength fixed by Government. Pre-war 67 posts <i>plus</i> fluctuating strength of probationers. Officers designated Extra-Assistant Superintendents. Pay on fixed time scale.</p> <p>Much increased intake in war.</p>
General Central Service— Class II.	<p>Some gazetted, some non-gazetted posts, strength fixed by Government. Pre-war 11 posts mainly for map publication offices.</p> <p>Additional posts in war for map publication and clerical expansion and scientific work. Time scale pay according to post.</p>
Upper Subordinate Service.	<p>Non-gazetted supervisory service, strength fixed by Government. Pre-war 85 posts on fixed time scale pay. Officers designated Sub-Assistant Superintendents.</p> <p>No increase during war, see <i>Topographical Assistants</i>.</p>
Fixed Clerical Posts.	<p>1st and 2nd Division, 57 posts, increased during the war.</p>
Division II.	<p>Non-gazetted service, strength fixed by Government. Pre-war 11 draftsmen, 17 map publication and 7 engravers posts. Pay on fixed time scale.</p> <p>Considerably increased during War.</p>
Lower Subordinate Service.	<p>Non-gazetted service, strength at discretion of Surveyor General subject to work requirements and budget. Contained plane-tableers ("surveyors"), air surveyors, computers and other technical field and drawing staff, as well as party and unit clerks. Service divided into grades according to skill and experience and into two classes according to energy and ability.</p> <p>Pay limits fixed by Government, at discretion of Surveyor General within these limits; pay on time scale with fluctuating increments depending on quality of work each year. Majority on quasi-permanent basis, promotion to permanent establishment partially controlled by Government rules.</p> <p>Much expanded during war.</p>

## Division III.

Non-gazetted service, in case of map reproduction personnel similar to Lower Subordinate Service ; contained printers, photographers, etc.

In the case of clerical establishment, a service whose strength and pay (fixed time scale) was decided by Government. Was used only for clerks in the Surveyor General's and the Director, Map Publication's offices. *Obsolescent.*

Map publication service much increased during war : clerical service decreased being replaced by Lower Subordinate clerks.

## Miscellaneous Superior Service Posts.

There were a number of posts to meet special needs in the "headquarter" offices, each sanctioned individually by the Government of India, on pay scales fixed by them. In the main, they do not enter the war picture.

Inferior Service.  
( now Class IV Service )

This service was effectually in three branches, field survey staff ( chainmen, etc. ), office staff ( peons, chuprasis, etc. ) and map publication staff ( technical labourers ).

The field and map publication strength was at the discretion of the Surveyor General ; the office staff in the "headquarter" offices was fixed, with its pay, by the Government of India to conform more or less to Secretariat methods and pay.

## SPECIAL WAR SERVICES

## Attached Military Cadres.

See *Cadres* in Annotated Index. Officers, B.O.R.'s and V.C.O.'s and Havildars were attached for duty in these cadres. Pay at military rates, promotion under military rules, and paid by Military Accounts authorities.

Topographical Assistants  
and Temporary Computers.

No fixed strength or pay. Recruited temporarily under the Surveyor General's own powers, virtually in lieu of Upper Subordinate Officers. Non-gazetted service though some held commissions in army and some were absorbed in Class II service.

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TABLE B.—*Rank and pay of Survey of India personnel on military service*

NOTE.—Military trade pay admissible only when drawing military rates of pay. Acting, temporary and war substantive rank admissible in accordance with military rules. *Either* military rates of pay or ( Part II ) civil pay with special allowances admissible, whichever more favourable. See Annotated Index, *Terms of Service, Trade Pay*.

I. *Substantive Military Rank and Military Trade Pay*

Civil qualifications	Substantive military rank	Trade pay p.m.
Class I ( Military ) Officer .. .. .	Own rank	Nil
Class I ( Civil ) Officer .. .. .	Captain	Nil
Class II Officer .. .. .	Lieutenant	Nil
Class II Probationer .. .. .	2nd Lieutenant	Nil
Sub-Asst. Superintendent ( Upper Subordinate Service ) in the selected grade on Rs. 350.	B.W.O. Class I or Subedar Major	Rs. 105
Second Division Map Publication Establishment Officer on pay over Rs. 300 except those in a special post.	„	„ 105
Sub-Asst. Superintendents ( Upper Subordinate Service excluding probationers ) not in the selected grade, and Topographical Assistants and Temporary Computers of over 3 years' service who were considered to be up to the standard of Sub-Asst. Supdts. and were recommended by the Surveyor General.	B.W.O. Class II or Subedar	„ 105
2nd Division Map Publication Establishment Officer on pay not over Rs. 300.	„	„ 105
Lower Subordinate Officer in the selected grade, or, in the case of new entrants as defined in the Survey of India Circular Order No. 422 corrected up to 1st January 1941, on passing the efficiency bar.	„	„ 90
First Division Assistants in the Headquarters Offices ( except Head Assistants ) and Upper Division, for new entrants after 1931.	„	„ 60
Probationers in the Upper Subordinate Service, Topographical Assistants and Temporary Computers of less than 3 years' service in the Survey of India.	Jemadar	„ 60
Lower Subordinate Service Officers of 1st Class or Class A ..	„	„ 90
Lower Subordinate Service Officers of Inter Class or Class B ..	„	„ 60
3rd Division Map Publication Establishment — Officers of Class 1 or 2 ( Class A or B for entrants after 1931 ).	„	„ 60

( contd. )

**TABLE B.—Rank and pay of Survey of India personnel on military service—( contd. )**

Civil qualifications	Substantive military rank	Trade pay p.m.
2nd Division and 3rd Division ( over 10 years' service ) Clerks in the Headquarters Offices ( Lower Division over 10 years' service for new entrants after 1931 ).	Jemadar	Rs. 60
Lower Subordinate Service Officers of 2nd Class or Class 'C' ..	Havildar	„ 60
Lower Subordinate Service Officers not included in the above ..	„	„ 45
3rd Division Map Publication Establishment Officers not included in any of the above.	„	„ 60
3rd Division ( under 10 years' service ) Clerk in the Headquarters Offices ( Lower Division under 10 years' service for new entrants after 1931 ).	„	„ 60
Khalāsi Jamadar, Daffadar, Duftry and inferior Map Publication Establishment of similar status and Geodetic Branch Workshop artificers.	Naik	..
Khalāsi, Tindal and Khalāsi Mate .. .. .	Lance Naik	..
Khalāsi .. .. .	Sepoy	..

( contd. )

TABLE B.—(concl.)  
 II. Allowances admissible when civil pay was drawn

Civil Qualifications	Out of India or in a field service area in India			
	In India when not in a field service area	Compensatory Allowance	Technical Pay	Special Compensatory Allowance
Class I (Military) Officers Class I (Civil) Officers	Nil	Nil	Nil	Nil
Class II Officers	12½% of civil pay or Rs. 10 per diem, whichever is less	25% of civil pay or Rs. 10 per diem, whichever is less subject to a minimum of Rs. 100 per month.	Rs. 187/8/- for officers on pay exceeding Rs. 999; Rs. 135/8/- for officers on pay of Rs. 999 and below.	Nil
U.S. Officers, Divn. II Lower Subordinate, etc., etc., non-gazetted personnel.	Do.	Do.	Rs. 135/8/- for officers on pay from Rs. 750 to Rs. 999; Rs. 112/8/- for officers on pay from Rs. 350 to Rs. 749; Rs. 90 for officers on pay less than Rs. 350.	Nil
Inferior Service	16½% of civil pay subject to a minimum of Rs. 50 for officers on pay above Rs. 200 per month; 25% of civil pay for officers on pay of Rs. 200 and below per month.	33½% of civil pay subject to a minimum of Rs. 100 for officers on pay above Rs. 200 per month; 50% of civil pay for officers on pay of Rs. 200 and below per month.	Nil	Rs. 90 for officers on pay above Rs. 299; Rs. 67/8/- for officers on pay from Rs. 200 to Rs. 299; Rs. 56/4/- for officers on pay from Rs. 100 to Rs. 199; Rs. 45 for officers on pay from Rs. 50 to Rs. 99; Rs. 22/8/- for officers on pay less than Rs. 50.
	25% of civil pay	50% of civil pay	Nil	Nil

TABLE C.—*Personnel in Civil and Military employ 1939-45*

NOTE.—Refer to Table A for explanation of Services.

SERVICE OR CADRE	Sep- tember 1939	August 1941			August 1943			August 1945			REMARKS
		Civil	Military	Total	Civil	Military	Total	Civil	Military	Total	
I	2	3	4	5	6	7	8	9	10	11	12
Class I (Military)	28	14	16	30	13	18	31	14	13	27	Includes General Central Service.
Class I (Civil)	9	18	..	18	20	..	20	24	..	24	
Class II	67	55	11	66	55	31	86	66	32	98	
Upper Subordinates	71	55	17	72	36	25	61	33	22	55	Several promoted.
Division II	30	30	1	31	32	3	35	49	1	50	
Topo. Assistants	..	..	..	..	31	6	37	70	27	97	Includes plane-tables and air surveyors. See <i>Sol-dier Surveyors</i> .
Surveyors	300	287	89	376	224	208	432	241	296	537	
Draftsmen	285	336	32	368	367	76	443	391	88	479	Map Publication personnel.
Computers	66	70	19	89	60	36	96	64	26	90	
Clerks and Store-keepers	207	239	35	274	292	57	349	406	91	497	
Map and Record Keepers	10	16	16	32	31	69	100	48	74	122	
Division II (Map)	298	328	69	397	407	86	493	478	48	526	
Other L.S.S., etc.	29	38	2	40	72	7	79	234	3	237	
<i>Total Survey of India</i>	<b>1400</b>	1486	307	<b>1793</b>	1640	622	<b>2262</b>	2118	721	<b>2839</b>	
Officers attached for duty	..	..	..	..	12	..	12	11	..	11	
B.O.R.'s attached for duty	..	..	..	..	64	..	64	107	..	107	
GRAND TOTAL	<b>1400</b>	1486	307	<b>1793</b>	1716	622	<b>2338</b>	2236	721	<b>2957</b>	

TABLE D.—*The Survey Organization in 1939 and in 1945*  
 Base military headquarters and units ( marked\* ) are shown in the Disposition List.  
 Others based on the Survey of India are grouped at the end. See *Base Organization, Military Organization*.

Location	September 1939	August 1945	Remarks and references to Annotated Index
Abbottābād	..	No. 2 Party .. Administrative Section* .. No. 4 Party .. Kulu Detachment ..	New New Replaced Officers' training school Replaced <i>Hazāra Detachment</i> } <i>Training Units.</i>
Bangalore	..	South India Party ..	<i>Eastern Circle, South India Party</i>
Bombay	..	Nil	<i>Stores Organization</i>
Calcutta	..	Surveyor General's Office Map Publication H.Q. No. 1 Drawing Office .. Photo-Litho Office .. Engraving Office .. Map Record and Issue Office .. Mathematical Instrument Office ..	To Delhi H.Q. to Dehra Dūn Main Office in Dehra Dūn Main Office in Dehra Dūn Transferred to Dept. of Supply } <i>Map Publication Circle.</i>
Calcutta ( Dum Dum )	Nil	Dy. Stores Office .. Map Sub Depot* .. Indian Air Survey and Transport Ltd.	<i>Stores Organization</i> <i>Charter Indian Air Survey and Transport</i>
Dehra Dūn	..	Geodetic Branch H.Q. No. 2 Drawing Office .. Forest Map Office .. Photo-Zinco Office .. Map Record Section .. Letterpress Printing Section .. Cantonments Detachment .. No. 1 Party ( Topo. ) ..	Augmented. <i>Letterpress Printing</i> Status raised. <i>Cantonments Party</i> <i>Eastern Circle, Geodetic Branch</i> } <i>Geodetic Branch.</i>

( contd. )



TABLE D.—*The Survey Organization in 1939 and in 1945.*—(contd.)  
Base military headquarters and units (marked\*) are shown in the Disposition List.  
Others based on the Survey of India are grouped at the end. See *Base Organization, Military Organization.*

Location	September 1939	August 1945	Remarks and references to Annotated Index
	Computing Office .. Scientific Parties and Offices .. Workshops .. Officers' Training School ..	Punjab Irrigation Party .. Burma Party (Nucleus) .. War Research Inst. H.Q. .. Computing Office .. Scientific Parties and Offices .. Workshops and Inst. Repairs ..  Eastern Circle H.Q. .. No. 5 Drawing Office .. No. 4 Party .. No. 5/12 Party ..  Stores Office ..  Survey Depot* .. Survey Training Centre ..	<i>Gurgaon</i> <i>Burma Survey Party</i>  <i>Geodetic Branch and War Research Institute</i>  Shared by G.B. and W.R.I. To Abbottabad. <i>Training Parties</i>  From Shillong. <i>Eastern Circle. Projects Officer</i> <i>Air Survey Officer</i>  New, Under Military Circle. <i>Stores Organization</i>  New, under { Director of Survey India { Director Military Circle { Military Circle Survey Depot
Dehra Dūn (Hāthibarkala)	Nil	Director of Planning, Maps Map Publication H.Q. No. 6 Drawing Office No. 1 Photo-Litho Office No. 1 Map Record and Issue Office	Publication Planning. <i>Map Publication</i> From Calcutta } From Simla } <i>Map Publication</i> New } <i>Map Publication Circle</i> New } <i>Hāthibarkala</i>
Delhi	Nil	Surveyor General's Office Military Circle H.Q. .. Geographical Section General Staff* Central Map Depot*	From Calcutta } New } <i>Base Organization</i> New } <i>Military Organization</i> New } <i>Military Circle</i>

(contd.)

TABLE D.—*The Survey Organization in 1939 and in 1945—(contd.)*  
 Base military headquarters and units (marked\*) are shown in the Disposition List.  
 Others based on the Survey of India are grouped at the end. See *Base Organization, Military Organization*

Location	September 1939	August 1945	Remarks and reference to Annotated Index
Dum Dum ..	..		See Calcutta, above
Hāthibarkala ..	..		See Dehra Dūn, above
Karāchi ..	"E" Company ..	Nil	To Murree, combined with "A". "E" Company
Lahore ..	Lahore Detachment ..	Nil	Work complete, disbanded. <i>Eastern Circle</i>
Maymyo ..	Burma Survey Party ..	Nil	<i>Burma. Burma Survey Party</i>
Murree ..	No. 18 (Air Survey) Party "A" Company.	Frontier Circle H.Q. No. 18 (Air Survey) Party A/E Party Map Publication Group	From Simla } <i>Frontier Circle</i> "E" Company } Air Survey Party }
Rānchi ..	Nil	Nil	No. 6 (Burma) Company reformed. <i>Burma Survey Party</i>
Risālpur ..	No. 18 (Air Survey) Party ..	Reproduction Group*	Winter only. <i>Frontier Circle</i>
Shillong ..	Eastern Circle H.Q. .. No. 5 Drawing Office .. No. 4 Party .. No. 5 Party .. No. 12 Party ..		To Dehra Dūn. <i>Eastern Circle</i>
Simla ..	Frontier Circle H.Q. No. 6 Drawing Office Army Section, 6 D.O.		To Murree } <i>Frontier Circle</i> To Dehra Dūn } <i>Army Section</i> Name changed to Simla Drawing } Section*, G.S.G.S. }
Non-Base ..	Nil	A. Under control of Surveyor General	Cadres.
Military Units ..		Officer Cadre VCO/Havildar Cadre	Military Survey Units.

(contd.)

TABLE D.—The Survey Organization in 1939 and in 1945—(concl.)

Location	September 1939	August 1945	Remarks and reference to Annotated Index
		<p>B. <i>Under Control of the Director of Survey, India</i></p> <p>Geographical Section, General Staff, G.H.Q., India</p> <p>Survey Depot with which is incorporated the Survey Training Centre (Civil).</p> <p>3 Command Survey Directorates</p> <p>1 Base Map Reproduction Section</p> <p>1 Map Supply Section</p> <p>1 Base Map Depot</p> <p>1 Draftsmen Unit I.G.S.C.</p> <p>C. <i>Under Control of the Director of Survey, ALFSEA</i></p> <p>ALFSEA Survey Directorate</p> <p>HQ SAC SEA Survey Directorate</p> <p>Survey Production Centre</p> <p>2 Army Survey Directorates</p> <p>3 Corps Survey Directorates</p> <p>1 Survey Directorate (Type C)</p> <p>6 Field Survey Companies</p> <p>2 Air Survey Companies</p> <p>7 Mobile Reproduction Groups</p> <p>1 Base Map Reproduction Section</p> <p>6 Map Supply Sections</p> <p>8 Survey Park Sections</p> <p>4 Air Survey Liaison Sections</p> <p>1 Air Survey Section</p> <p>1 Map Reproduction Company</p> <p>1 Map Supply Company</p>	

TABLE E.—*Survey of India personnel on military service*

Regular Military Officers	Substantive Rank at close of Military Service	Temporary Rank	Overseas Theatres
Angwin, J. B. P., M.B.E., R.E. . .	Lt.-Colonel	Colonel	Persia/'Irāq.
Biddle, C. A., R.E. . .	Captain	Lt.-Colonel	Persia, South-East Asia Command.
Bomford, G., O.B.E., R.E. . .	Lt.-Colonel	Colonel	Persia/'Irāq, S.W. Pacific, Burma, S.E.A.C.
Clementi, D. M., R.E. . .	Captain	Major	..
Crone, D. R., C.I.E., O.B.E., R.E.	Major	Colonel	..
Edge, R. C. A., M.B.E., R.E. . .	Captain	Lt.-Colonel	South-East Asia Command.
Gambhir Singh, I.A. . .	Captain	Major	Persia/'Irāq.
Gardiner, R. A., M.B.E., R.E. . .	Captain	Lt.-Colonel	Persia/'Irāq, Mid.-East.
Glennie, E. A., C.I.E., D.S.O. . .	Colonel	Brigadier	.
Heaney, G. F., C.B.E. . .	Colonel	Brigadier	Persia/'Irāq, South-East Asia Command.
Jenney, R. C. N., R.E. . .	Major	..	Persia/'Irāq.
Kalha, R. S., I.A. . .	Captain	Major	Burma, South-East Asia Command.
Osmaston, G. H., M.C. . .	Colonel	Brigadier	Persia/'Irāq.
Paintal, J. S., I.E. . .	Captain	Major	South-East Asia Command.
Rogers, R. T. L., R.E. . .	Captain	Lt.-Colonel	Persia/'Irāq. Middle East, South-East Asia Command.
Sams, R. H., R.E. . .	Major	..	Persia/'Irāq.
Thackwell, D. E. O., R.E. . .	Captain	Lt.-Colonel	Burma, Thailand.
Verma, A. D. . .	Captain	..	Persia/'Irāq.
Williams, L. H., R.E. . .	Captain	Major	Persia/'Irāq, South-East Asia Command.
Wilson, C. A. K., O.B.E., R.E., . .	Major	Colonel	Persia/'Irāq, Burma
Wilson, I. H. R., R.E. . .	Major	Colonel	Burma/S.E.A.C.
Wright, H. W., O.B.E., R.E. . .	Major	Lt.-Colonel	Burma.
Ahad, A. . .	Lieut.	Captain	Persia/'Irāq, Burma.
Aggarwala, G. C. . .	Lieut.	Captain	Burma.
Anand, O. P. . .	Lieut.	Captain	S.E.A.C.

(contd.)

TABLE E.—*Survey of India personnel on military service—(contd.)*

Emergency Commissioned Officers	Substantive Rank at close of Military Service	Temporary Rank	Overseas Theatres
Bagnall, L. J. .. ..	Lieut.	Captain	Mid.-East.
Berry, J. C. .. ..	Lieut.	Captain	Persia, 'Irāq.
Bower, G. E. .. ..	Lieut.	Captain	S.E.A.C.
Critchell, H. M. .. ..	Lieut.	Major	Burma.
Dalal, J. A. F. .. ..	Lieut.	Captain	S.E.A.C.
Dhawan, K. L. .. ..	Lieut.	Major	Persia, 'Irāq.
Dhawan, N. N. .. ..	Lieut.	Captain	Persia, 'Irāq.
Duggal, K. N. .. ..	Lieut.	Captain	S.E.A.C.
Ganapathy, M. A. .. ..	Lieut.	Captain	S.E.A.C.
Hassan, S. S. .. ..	Lieut.	Captain	'Irāq.
Hashmie, M. N. A. .. ..	Lieut.	Captain	Persia, 'Irāq.
Hawley, F. M. .. ..	Lieut.	Captain	Burma.
Hayman, C. V. M. .. ..	Lieut.	..	'Irāq.
Hurley, C. T. .. ..	Lieut.	Captain	Burma.
Jain, P. K. .. ..	Lieut.	Captain	S.E.A.C.
Khan, M. A. .. ..	Lieut.	Captain	Burma.
Kohli, J. N. .. ..	Lieut.	..	'Irāq.
Kuttappa, B. B. .. ..	Lieut.	Captain	S.E.A.C.
Mamgain, U. D., C.H. .. ..	Lieut.	Captain	Burma.
Maulick, A. C. .. ..	Lieut.	Captain	'Irāq.
Michael, S. .. ..	Lieut.	Captain	Persia, 'Irāq.
Mudaliar, S. K. S. .. ..	Lieut.	Captain	S.E.A.C.
Muthanna, K. B. .. ..	Lieut.	Captain	'Irāq.
Phillips, H. H. .. ..	Lieut.	Captain	Persia, 'Irāq.
Ponnappa, I. K. .. ..	Lieut.	Captain	Burma.
Qureshi, A. R. .. ..	Lieut.	Major	Burma.
Ramanathan, A. N. .. ..	Lieut.	Captain	Persia, 'Irāq. S.E.A.C.
Rassaby, H. S. .. ..	Lieut.	..	S.E.A.C.
Ross, J. C. .. ..	Lieut.	Captain	Persia, 'Irāq.

(contd.)

TABLE E.—*Survey of India personnel on military service—(concl'd.)*

Emergency Commissioned Officers			Substantive Rank at close of Military Service	Temporary Rank	Overseas Theatres
Sen, N. C.	..	..	Lieut.	Captain	Persia, 'Irāq.
Sheikh, K. A.	..	..	Lieut.	Captain	Persia, 'Irāq.
Shinghal, P. S.	..	..	Lieut.	Captain	Persia, 'Irāq.
Teja Singh	..	..	Lieut.	Captain	Persia, 'Irāq.
Thomas, P. A.	..	..	Lieut.	Major	Persia, 'Irāq.
Wilson, E. R.	..	..	Lieut.	Major	S.E.A.C.
Zaki, A. N. K.	..	..	Lieut.	Captain	S.E.A.C.

TABLE F.—Honours gained by Survey of India personnel

CIVIL	
<p><i>Knighthood</i>  Lewis, Brigadier C. G., C.B.E.  Wheeler, Brigadier E. O., M.C.</p> <p><i>C.I.E.</i>  Crone, Lt.-Colonel D. R., O.B.E.  Glennie, Brigadier E. A., D.S.O.  Phillimore, Colonel R. H.  Slater, Colonel O., M.C.</p> <p><i>O.B.E.</i>  Crone, Lt.-Colonel D. R.  Wright, Lt.-Colonel H. W.</p> <p><i>M.B.E.</i>  Colquhoun, S.  Drake, A. J. A., D.O.M.  Mudaliar, M. M.  Peychers, H. J.  Verma, Rai Bahadur D. C.  Wass, Major W. H.</p> <p><i>Rai Bahadur</i>  Verma, Rai Sahib D. C.</p> <p><i>Khan Bahadur</i>  Muhammad Hasan, Khan Sahib.</p> <p><i>Rai Sahib</i>  Banerji, D. N.  Banerji, H. C.  Verma, D. C.</p> <p><i>Khan Sahib</i>  Chiragh Shah.  Muhammad Aslam, Chowdhury.</p> <p><i>Certificate of Honour</i>  Ahmad Said.  Arokiasvami, Capt. D.  Fazal Ellahi, Sub.  Govindaraj, Sub. C.</p>	<p>Iqbal Muhammad, Sub.  Kar, H. K.  Khan, Sub. Manawar.  Khan, Sub. Sarwar.  Kukreti, Jem. R. P.  Mamgain, U. D.  Mughli Ram.  Muthanna, Sub. K. B.  Qureshi, Sub. Mohd. Z. A.</p> <p><i>Commendation Certificate</i>  Adaikalanathan, Sub. S.  Ahmad Hossain.  Ahmad Said.  Alam, Sub. Mohd.  Bist, Jem. Bhagat Singh.  Chatterjee, Sub. T. K.  Gopalaswamy, Jem. C.  Ismail, Sub. Mohd.  Jai Prakash, Sub.  Joshi, Sub. C.  Khan, Sub. Hossain.  Khan, Sub. Manawar.  Lal Mir, Jem.  Jagannath, Naib-Jem.  Modhi, Hali Ram.  Mukherji, S. P.  Nabi, Shaikh Gholam.  Panwar, Jem. M. S.  Pema Jagannath.  Ray, N. K.  Sen Gupta, P. C.  Sharma, Sub. B. R.  Singh, Jem. Gajai.  Singh, Jem. Gurdit.  Singh, Sub. Nasib.  Singh, Shamsheer.  Singh, Jem. Teja.  Wahab, Sub. Abdul.</p>
MILITARY	
<p><i>C.B.E.</i>  Heaney, Brigadier G. F.</p> <p><i>O.B.E.</i>  Bomford, Colonel G.  Wilson, Colonel C. A. K.</p> <p><i>M.B.E.</i>  Edge, Major R. C. A.  Gardiner, Major R. A.  Wilson, Colonel C. A. K.</p> <p><i>Mention in Despatches</i>  Aggarwala, Capt. G. C.  Angwin, Lt.-Colonel J. B. P.  Asghar, Jem. Ali.  Bist, Jem. Bhagat Singh.  Dhawan, Major K. L.  Edge, Major R. C. A.  Ellahi, Sub. Fazal.  Hashim, Jem. S. M.  Hurley, Major C. T.  Jenney, Major R. C. N.  Kalha, Colonel R. S.  Khan, Major M. A.</p>	<p>Khan, Sub. Sarwar.  Madhwa Nand, Jem.  Mamgain, Capt. U. D.  Mughli Ram, Sub.  Muthanna, Lt. K. B.  Naik Mustamir.  Quraishi, Major A. R.  Qureshi, Sub. Mohd. Z. A.  Ross, Capt. J. C.  Sen Gupta Hav. Sarojmoy.  Shakir, Sub. A. T.  Singh, Jem. Bachan.  Singh, Jem. Fateh.  Singh, Jem. Gajai.  Singh, Sub. Gurdit.  Singh, Sub. Nasib.  Singh, Jem. Teja.  Sinha, Major J. N.  Thomas, Major P. A.  Tomar, Jem. B. S.  Vaikunthanathan, Sub. S.  Wilson, Lt.-Colonel C. A. K.  Wilson, Lt.-Colonel I. H. R.</p>

TABLE G.—*Casualties and re-employments*

## I. BATTLE CASUALTIES

Killed in action	Missing believed killed	Died of disease	Prisoners of War
L/Naik Bana Ram	Jardine, Lt. Wilson	..	Hunter, Dr. J. de Graaff while travelling in S.S. Zam Zam.
Naik Chander Singh	..	..	Jardine, Lt. Wilson.

## II. OTHER WAR CASUALTIES

Deaths	Hurt	Cause
Barua, B. N.	One Class IV	Train accident near Monywa, while on evacuation. Burma on 19-4-42.
Bukhari, S. M.		
Nayadu, R. S.		
Sen, Hav. G. C.		
Seven—( Class IV service ) ..	..	Died of disease.
Abdul Rahman, Jemadar ..	..	
Aurora, Jemadar Gian Chand	..	
Ghosh, Jemadar S. K. ..	..	
Ghulam Nabi, Hav. ..	..	
Gujral, Hav. Om Prakash ..	..	
Khushi Ram, Jemadar ..	..	
Mascharak, Jemadar, K. P.	..	
Roy, Hav., A. K. ..	..	
Singh, Jemadar Chet ( Lower Subordinate Service )	..	
Sharpe, Pte. H. ( B.O.R. Cadre ) ..	..	Died of accident, in Ceylon.
		Died of disease.

## III. NORMAL CASUALTIES

## DEATHS

Abdul Malik ( Division II ).	Robertson, G. A. ( Class II ).
Banerji, A. C. ( Division II ).	Siddique, A. N. ( Class II ).
Chander, N. N. ( 1st Division Assistant ).	Lower Subordinate Service .. 47
Chaudhuri, M. N. ( G.C.S. Class II ).	Division III .. 32
Kurup, R. R. K. ( U.S.S. ).	Inferior Service .. 6
Norman, A/Col., W. J. ( Class I ).	

( contd. )



TABLE G.—*Casualties and re-employments*—(concl'd.)

## III NORMAL CASUALTIES

SUPERANNUATIONS	
Abdul Hamid ( Division II ).	Das, S. K. ( Division II ).
Abdul Rahman ( Division II ).	Dhara, G. M. ( G.C.S. Class II ).
Ahmed, S. I. ( U.S.S. ).	Drake, A. J. M., D.C.M. ( Class I ).
Bagchi, G. S. ( U.S.S. ).	Glennie, Col. E. A. ( Class I ).
Bagdwal, D. S. ( Head Assistant ).	Grant, F. H. ( Class I ).
Banerji, D. N. ( Class I ).	Grice, F. J. ( Class I ).
Banerji, H. C. ( Class II ).	Hastir, R. N. ( Class II ).
Banerji, K. C. ( Division II ).	Iyer, N. S. H. ( Class I ).
Basu, J. N. D. ( Division II ).	Jackson, O. D. ( Class II ).
Bhattacharji, J. K. ( Division II ).	Jackson, Col. L. H. ( Class I ).
Biggie, W. H. ( Class I ).	Kapur, C. L. ( Class II ).
Biswas, B. D. ( Head Assistant ).	Khusal Khan ( U.S.S. ).
Bose, P. N. ( Division II ).	King, Col. F. J. M. ( Class I ).
Chatarji, G. K. ( 1st Division Assistant ).	Lal, J. B. ( Class II ).
Chatarji, M. N. ( U.S.S. ).	Lewis, Brig. Sir Clinton ( Class I ), ( S.G. ).
Chatarji, S. N. ( Division II ).	Mandanna, K. G. ( U.S.S. )—Invalided.
Chukerbutty, N. N. ( Class I ).	Mariadas, R. ( Division II ).
Colquhoun, S. C. ( G.C.S. Class I ).	Matlub Ahmed, D. A. S. ( U.S.S. ).

TABLE H.—*Expansion in Map Publication Plant & Machinery*

NOTE :—The Army Section No. 6 D.O. is not included.  
See Annotated Index, *Plant and Machinery*.

Description of Plant and Machinery	1939	August 1945					Frontier Circle*	TOTAL
		Map Publication Circle		Geodetic Branch	6			
		Calcutta	Hâthibarkala					
1	2	3	4	5				
Printing Machines								
Flat-bed of various sizes H/F ..	10	3	1	1		2	7	
Hand-feed Rotary Offset D-Demy H/F ..	5	4	1	3		3	11	
Auto-feed Rotary Offset :—								
Demy 2-colours ..	..	..	..	2		..	2	
Double Demy Single Colour ..	..	1	1	4		1	7	
“ “ 2-colour ..	..	1	3	2		1	7	
Quad Demy Single Colour ..	..	2	3	..		..	5	
“ “ 2-colour ..	..	..	2	..		..	2	
Baby Mann Single Colour ..	..	..	2	..		..	2	
“ Harris “ “ ..	..	..	1	..		..	1	
TOTAL ..	15	11	14	12		7	44	

(contd.)

\* Includes F.C.O. ( Murree and Risālpur ) and Risālpur 72 Reps.

TABLE H.—*Expansion in Map Publication Plant & Machinery—( contd. )*

NOTE :—The Army Section No. 6 D.O. is not included.  
See Annotated Index, *Plant and Machinery*

Description of Plant and Machinery	1939	AUGUST 1945					TOTAL
		Map Publication Circle		Geodetic Branch	Frontier Circle*		
		Calcutta	Hāthibarkala				
1	2	3	4	5	6		
Proving Presses							
Duplicating Presses .. ..	3	3	10	..	4	17	
Transfer Presses all sizes ( Hand Direct ) ..	24	12	7	7	4	30	
Mobile Hand Presses ( Mule Transport Portable ) ..	..	..	..	..	3	3	
TOTAL ..	27	15	17	7	11	50	
Ware-house Machines							
Varnishing machine .. ..	..	..	1	..	..	1	
Paper conditioning machines ..	..	1	2	1	..	4	
Perforating machine ( Hand ) ..	..	..	1	..	..	1	
Guillotining machines .. ..	2	2	6	2	3	13	
TOTAL ..	2	3	10	3	3	19	

\* Includes F.C.O. ( Murree and Risālpur ) and Risālpur 72 Reps.

( contd. )

TABLE H.—*Expansion in Map Publication Plant & Machinery—(concl.)*

NOTE:—The Army Section No. 6 D.O. is not included.  
See Annotated Index, *Plant and Machinery*.

Description of Plant and Machinery	1939	August 1945				TOTAL
		Map Publication Circle		Geodetic Branch	Frontier Circle*	
		Calcutta	Hathibarkala			
1	2	3	4	5	6	
Miscellaneous						
Printing Frames ..	6	7	12	9	7	35
Whirlers ..	2	2	4	2	4	12
Plate graining machines..	8	5	8	2	3	18
Ink grinding mill ..	2	..	2	..	..	2
Cameras—Room ..	2	..	2	3	1	6
“ —Process ..	8	8	6	..	3	17
“ —Portable ..	3	2	1	1	..	4
Arc Lamps ..	14	14	14	7	5	40
Rotary converters ..	2	..	..	2	..	2
Letterpress ..	7	5	..	..	..	5
Levigators ..	..	..	1	1	1	3
TOTAL ..	54	43	50	27	24	144

\* Includes F.C.O. (Murree and Risálpur) and Risálpur 72 Reps.

TABLE J.—*Maps published and issued 1938-1945*  
( See Annotated Index, *Map Publication, Map Issues* )

Year	Maps published		Average Run	Maps issued		TOTAL
	Individual Maps	Copies Printed		To armed forces	To others	
1	2	3	4	5	6	7
<b>1-4-38 to 31-3-39</b>	<b>1,580</b>	<b>721,000</b>	<b>460</b>	<b>111,000</b>	<b>409,000</b>	<b>520,000</b>
1-4-39 to 31-3-40	1,660	824,000	500	159,000	435,000	594,000
1-4-40 to 31-3-41	1,850	1,331,000	720	554,000	654,000	1,208,000
1-4-41 to 31-7-42*	5,610	8,217,000	1,460	6,466,000	265,000	6,731,000
1-8-42 to 31-7-43	3,441	20,575,000	6,000	21,960,000	165,000	22,125,000
1-8-43 to 31-7-44	2,281	11,787,000	5,200	12,768,000	403,000	13,171,000
1-8-44 to 31-7-45	2,483	22,075,000	8,900	20,758,000	589,000	21,347,000
<b>Total ..</b>	<b>17,325</b>	<b>64,809,000</b>	<b>22,780</b>	<b>62,665,000</b>	<b>2,511,000</b>	<b>65,176,000</b>

\* 16 Months. Date of reporting changed from 31st March to 31st July.

## NOTES.—

1. In addition to maps published by the Survey of India, the Army Section ( No. 6 Drawing Office ) and, from 1943 on, military units in India and SEAC based on the Survey of India published a steadily increasing number of maps reaching a peak of about 24,000,000 in 1944-45. The combined total published by the Survey of India and the military units in the Eastern Theatre was a little under 100,000,000 maps. Up to 1942 the Army Section published maps.
2. The increase in length of run ( Column 4 ) reflects not only the building up of military forces in the Eastern Theatre but also the increase in scale of issue to the troops as the war progressed.
3. The large increase in 1942-43 reflects the build up of maps for the Japanese war, while the lull ( and shorter runs ) in 1943-44 reflects the uncertainty at that time of where the final offensive would take place.
4. Column 7—Column 3 represents the drop in stocks on Survey of India shelves, amounting to 367,000 maps ; this is a considerable number of maps under peace conditions, being over half a full year's pre-war publication.
5. The increase in civil issues early in the war reflects demands in connection with factories, airfields, etc. That late in the war reflects demands for grow-more-food projects, geological activities, etc.

See the Annotated Index, *Map Publication, Map Issues, Projects.*

TABLE K.—*Letterpress Printing* ( See Annotated Index )

Item	Pages printed
General Reports, 1939, 1940, 1941 .. ..	167
Geodetic Reports, 1939, 1940, 1941 .. ..	282
War Research pamphlets .. ..	188
Levelling pamphlets .. ..	1,540
Trigonometrical Data supplied to army .. ..	1,478
Grid pamphlets .. ..	1,648
Tide-tables .. ..	3,567
Grid tables .. ..	129
Mathematical tables .. ..	966
Survey Service Pocket Book, etc. .. ..	619
Other technical publications .. ..	2,247
Footnotes for maps Letters for "paste-on" names and numbers }	16,706 Impressions
Type cast for hand typing .. ..	
	5.418 tons



**TABLE L.—***Survey of India officers holding posts as Directors, Deputy and Assistant Directors and those commanding Survey Companies and the Survey Depot*

1940–1946		
<b>DELHI</b>		
D. Survey I. Command ..	Col. E. O. Wheeler, M.C. ..	Feb. 41–Apr. 41
	Brig. E. A. Glennie, C.I.E., D.S.O.	Apr. 41–Mar. 46
	Brig. G. Bomford ..	Sept. 42–Nov. 42
	Brig. G. H. Osmaston, M.C. ..	Mar. 46–Feb. 48
A.D. Survey ..	Lt.-Col. D. E. O. Thackwell ..	Nov. 43–May 45
	Lt.-Col. R. A. Gardiner, O.B.E.	45–Apr. 47
<b>‘IRĀQ</b>		
D.D. Survey British Troops ‘Irāq and 10th Army ..	Col. G. F. Heaney ..	Nov. 41–Apr. 43
A.D. Survey H.Q. (Pairforce) ..	Lt.-Col. C. A. K. Wilson, R.E.	Dec. 42–Apr. 43
A.D. Survey 1 H.Q. ..	Lt.-Col. J. B. P. Angwin, M.B.E., R.E. ..	Apr. 41–May 42
A.D. Survey 2 H.Q. ..	Lt.-Col. G. H. Osmaston, M.C., R.E. ..	Apr. 41–Apr. 42
	Lt.-Col. J. B. P. Angwin, M.B.E., R.E. ..	May 42–July 42
A.D. Survey 4 H.Q. ..	Lt.-Col. G. Bomford, R.E. ..	July 41–Dec. 41
A.D. Survey I.E.F. ..	Lt.-Col. C. A. K. Wilson, R.E.	Apr. 43–June 43
<b>S.W.P.</b>		
D.D. Survey South-West Pacific ..	Col. G. Bomford ..	Jan. 42–Apr. 42
<b>BURMA FRONTIER</b>		
D.D. Survey E. Army ..	Col. G. Bomford ..	Apr. 42–Sept. 42
	Col. J. B. P. Angwin, M.B.E. ..	Sept. 42–Nov. 42
	Col. G. Bomford ..	Nov. 42–Oct. 43
D.D. Survey 14th Army	Col. G. Bomford ..	Oct. 43–May 45
D.D. Survey 121 IA. Dte.	Col. J. B. P. Angwin, M.B.E. ..	May 45–Nov. 45
D.D. Survey 12th Army	Col. C. A. K. Wilson, M.B.E., R.E.	May 45–Nov. 45
A. D. Survey, Burma Surveys ..	Lt.-Col. H. W. Wright, R.E. ..	Dec. 41–May 42
A.D. Survey 6 H.Q. ..	Lt.-Col. H. W. Wright, R.E. ..	May 42–Mar. 43
A.D. Survey 9 H.Q. ..	Lt.-Col. H. W. Wright, O.B.E., R.E. ..	Mar. 43–June 43
A.D. Survey 9 H.Q. ..	Lt.-Col. C. A. K. Wilson, M.B.E., R.E. ..	June 43–Oct. 45
A.D. Survey 4 Corps (later 101 Dte.) ..	Lt.-Col. I. H. R. Wilson, R.E. ..	Mar. 43–Sept. 44
A.D. Survey 15 Corps (later 102 Dte.) ..	Lt.-Col. R. C. A. Edge, R.E. ..	Jan. 44–Apr. 44
	Lt.-Col. C. A. Biddle, R.E. ..	Apr. 44–May 44
	Lt.-Col. R. C. A. Edge, R.E. ..	Aug. 45–Oct. 45
	Lt.-Col. C. A. Biddle, R.E. ..	Oct. 45–Feb. 46

(contd.)



TABLE L.—*Survey of India officers holding posts as Directors, Deputy and Assistant Directors and those commanding Survey Companies and the Survey Depot—( conclud. )*

1940-1946		
A.D. Survey 33 Corps ( later 103 Dte. ) ..	Lt.-Col. I. H. R. Wilson, R.E. ..	Sept. 44-Oct. 44
	Lt.-Col. C. A. Biddle, R.E. ..	Oct. 44-Oct. 45
O.Cs. 6 Company ..	Major I. H. R. Wilson, R.E. ..	June 42-Feb. 43
	Major H. M. Critchell, R.I.E. ..	Feb. 43-May 43
	Major R. S. Kalha, I.A. ..	May 43-Aug. 45
	Major M. A. Khan, R.I.E. ..	Sept. 45-Mar. 46
<b>SOUTHERN COMMAND</b>		
D.D. Survey 11 H.Q. ( later S. Army ) ..	Col. J. B. P. Angwin, M.B.E. ..	Jan. 43-May 45
A.D. Survey S. Army ..	Lt.-Col. J. B. P. Angwin, M.B.E., R.E. ..	Aug. 42-Jan. 43
<b>AIR</b>		
D.D. Survey 12 I.F.S. H.Q. ( later Air Svy. Dte. ) ..	Col. D. R. Crone, O.B.E. ..	Mar. 43-Apr. 44
	Col. I. H. R. Wilson ( D.D. Survey ) ..	Oct. 44-Jan. 45
	Col. I. H. R. Wilson ( D.D. Survey ) ..	Jan. 45-Mar. 45
	Lt.-Col. L. H. Williams ( A.D. Survey ) ..	May 44-June 44
	Lt.-Col. R. T. L. Rogers ( A.D. Survey ) ..	July 44-Mar. 45
<b>S.E.A.C.</b>		
D. Survey 11 Army Group ( later ALFSEA ) ..	Brig. G. F. Heaney, C.B.E. ..	Feb. 44-Oct. 45
	Brig. G. Bomford, O.B.E. ..	Oct. 45-Apr. 46
A.D. Survey 11 Army Group ( later ALFSEA )	Lt.-Col. R. T. L. Rogers ..	Apr. 45-Dec. 46
	Lt.-Col. C. A. Biddle ..	Mar. 46
O.Cs. 1 Company ..	Major R. C. N. Jenney, R.E. ..	Apr. 41-Oct. 42
	Major R. T. L. Rogers, R.E. ..	Oct. 42-Feb. 44
	Major P. A. Thomas, R.I.E. ..	Feb. 44-Aug. 45
	Major J. S. Paintal, R.I.E. ..	Aug. 45 —
O.Cs. 2 Company ..	Major R. H. Sams, R.E. ..	Apr. 41-July 42
	Major Gambhir Singh, I.A. ..	July 42-Dec. 43
	Major H. M. Critchell, R.I.E. ..	Dec. 43-May 44
	Major R. C. A. Edge, R.E. ..	May 44-Aug. 44
	Major A. R. Quareshi, R.I.E. ..	Aug. 44-Jan. 47
O.Cs. 3 Company ..	Major C. A. Biddle, R.E. ..	Nov. 42-Oct. 43
	Major D. M. Clementi, R.E. ..	Oct. 43-Nov. 44
	Major J. C. Ross, R.I.E. ..	Apr. 45-Sept. 46
O.Cs. 4 Company ..	Major C. A. K. Wilson, R.E. ..	July 41-Oct. 42
	Major L. H. Williams, R.E. ..	Nov. 42-Dec. 43
	Major Gambhir Singh, I.A. ..	Dec. 43-Apr. 45
	Major J. S. Paintal, R.I.E. ..	Apr. 45-July 45
O.Cs. 5 Company ..	Major R. S. Kalha, I.A. ..	Oct. 42-May 43
	Major E. R. Wilson, R.I.E. ..	May 43-Dec. 43
	Major K. L. Dhawan, R.I.E. ..	Dec. 43-Nov. 45
O.Cs. 7 Company ..	Major L. H. Williams, R.E. ..	Dec. 43-May 44
	Major E. R. Wilson, R.I.E. ..	June 44 —
O.Cs. Survey Depot. ..	Major I. H. R. Wilson, R.E. ..	Oct. 40-June 42
	Major D. M. Clementi, R.E. ..	June 42-Oct. 43

TABLE M.—War Establishment and War Equipment Tables.  
Indian Field Survey Sub-Units ( showing typical units ).

SUB-UNIT	SURVEY OF INDIA SUPPLY					ARMY SUPPLY ( including attached ) (h)					REMARKS	
	Officers	V.C.O.'s (c)	Havildars (c)	Other ranks	N.C. (E)	Officers	V.C.O.'s (c)	Havildars (c)	Other Ranks	N.C. (E)		Total Sub-Unit
Directorate ( A.D. or D.D. Svys. )	1	1	1	8(a)	..	..	..	..	2	1	14	(a) Includes officers' orderlies.
General Section	..(b)	5(b)	5	11	..	..	..	..	2	4	27	(b) An officer may replace a subedar in the General Section of a H.Q. in which case there will be one extra I.O.R. as officers' orderlies.
TOTAL TYPICAL Fd. SVY. H.Q.	1	6	6	19	..	..	..	..	4	5	41	
Drawing Section	..	5	4	6	..	..	..	..	..	..	15	
Map Supply Section	1	4	2	14(a)	..	..	..	..	4	1	26	
Survey Park Section	..	2	2	11	..	..	..	..	1	1	17	
Company H.Q.	4	4	1	41(a)	..	1	3	3	38	13(i)	108	(c) The proportion of V.C.O.'s and Havildars may be varied with circumstances.
General Section	..	5	5	11	..	..	..	..	2	4	27	(d) 2 ground survey sections per typical company.
Air survey section	..	4	2	4	..	..	..	..	..	..	10	(e) 2 printing sections per typical Rep. Gp.
Ground survey section (d)	1	6	4	32(a)	..	..	..	..	7	4	54	
Total typical Coy. (d) less Rep. Gp. ..	6	25	16	120	..	1	3	3	54	25	253	

( contd. )

TABLE M.—War Establishment and War Equipment Tables—(contd.)  
*Indian Field Survey Sub-Units (showing typical units)*

SUB-UNIT	SURVEY OF INDIA SUPPLY					ARMY SUPPLY ( including attached ) (h)					REMARKS	
	Officers	V.C.O.'s (c)	Havildars (c)	Other Ranks	N.C. (E)	Officers	V.C.O.'s (c)	Havildars (c)	Other Ranks	N.C. (E)		Total Sub-Unit
Rep. Gp. H.Q. (f)	1	5	9	22(a)	..	..	..	1	34	6	78	(f) All army personnel is allotted to H.Q. group. It will be distributed to sections as required.
Camera Section	..	2	5	8	..	..	..	..	..	..	15	
P.Z. Section	..	1	3	11	..	..	..	..	..	..	15	
Printing Section (e)	..	1	3	7	..	..	..	..	..	..	11	
Total typical Rep. Gp. (e)	1	10	23	55	..	..	..	1	34	6	130	(g) H.Q. General Section, Air Survey section, H.Q. Rep. Gp. Camera section, P.Z. section, 2 Printing sections.
TOTAL TYPICAL COMPANY (g)	7	35	39	175	..	1	3	4	88	41	393	(h) Signallers, Tradesmen, Medical personnel, R.I.A.S.C. personnel.
												(i) Of which 5 are officers' mess servants,

( contd.. )

(contd.)

TABLE M.—War Establishment and War Equipment Tables—(contd.)  
Transport

	Bicycles	Motor Cycles Heavy	Car Str. Wagon	Trucks 15 Cwt. G.S.	Lorries 30 Cwt. F.W.D.	Tractors Survey	Trailer Light Tank Recovery	Trailer Water Tank 110 gal.	Trailer Water Tank 110 gal.	Lorries 3-ton G.S.	Total (excluding bicycles, motor cycles and trailers)	
Directorate	1	1	1	1	1	1	1	1	1	1	1	(a) 2 ground survey sections per typical company.
General Section	1	1	1	1	1	1	1	1	1	1	1	(b) 2 printing sections per typical Rep. Gp.
TOTAL TYPICAL Fd. SVY. H.Q.	2	2	1	1	1	1	1	1	1	1	2	
Drawing Section	2	1	1	1	1	1	1	1	1	1	2	
Map Supply Section	1	1	1	1	1	1	1	1	1	1	1	
Survey Park Section	1	1	1	1	1	1	1	1	1	1	1	
Company H.Q.	1	1	1	1	1	1	1	1	1	1	7	
General Section	1	1	1	1	1	1	1	1	1	1	1	
Air Survey Section	1	1	1	1	1	1	1	1	1	1	1	
Ground Survey Section (a)	1	2	1	1	1	1	1	1	1	1	5	
Total typical Coy. (a) less Rep. Gp.	4	6	1	3	13	1	1	1	1	1	18	
Rep. Group H.Q.	1	1	1	1	1	1	1	1	1	1	2	
Camera Section	1	1	1	1	1	1	1	1	1	1	3	
P.Z. Section	1	1	1	1	1	1	1	1	1	1	1	
Printing Section (b)	1	1	1	1	1	1	1	1	1	1	4	
Total Typical Rep. Gp. (b)	1	1	1	1	1	2	2	1	1	11	14	
TOTAL TYPICAL COMPANY	5	6	1	4	13	2	2	1	1	12	32	

NOTE.—2nd line transport will be found as required from pooled resources. The approximate lift for a company is equivalent to:—7 lorries 30 cwt. for Rep. Gp. 13 lorries 30 cwt., for remainder.

(contd.)

TABLE M.—( *contd.* )*Some Important items of War Equipment and Stores*

Item	Typical H.Q.	Typical Coy.	Park Section	REMARKS
ORDNANCE STORES				
Binoculars .. ..	14	48	..	
Compasses, prismatic, liquid ..	6	40	..	
Heliographs, 5-inch. . .	..	24	4	
Lamps, signalling, day-light ..	..	10	..	
Range-finders, artillery pattern ..	..	2	..	
Spectacles, tinted, No. 3 pairs ..	6	39	..	
Telescopes, signalling ..	..	8	..	
Watches, stop, 1/10 second ..	2	13	..	
Chaguls, universal .. ..	44	382	20	
Pails, 3½ gallon .. ..	2	12	..	
Tanks, canvas, 50-gallon ..	..	11	..	
Tanks, canvas, 500-gallon ..	..	1	..	
Tanks, mule .. ..	..	14	..	
Lamps, incandescent, small ..	..	35	..	
STATIONERY DEPARTMENT STORES				
Cloth, tracing, 36" wide, yards ..	60	192	192	
Colours, water : Cobalt, crimson, viridian, light red, burnt sienna, burnt umber, vermillion, aureolin ( or ochre ), yellow, each cakes ..	7	60	60	
Ink, Indian ( Chinese ) sticks ..	12	76	80	
Ink, waterproof : Black bottles .. ..	4	30	..	} Lesser quanti- ties of other colours.
White bottles .. ..	4	28	..	
Burnt sienna bottles ..	2	12	..	
Kodatrace, extra heavy, 40" × 22 yds. Rolls ..	1	4	4	

( *contd.* )

TABLE M.—( *contd.* )*Some Important items of War Equipment and Stores*

Item	Typical H.Q.	Typical Coy.	Park Section	REMARKS
STATIONERY DEPARTMENT STORES ( <i>concl'd.</i> )				
Paper, drawing :				All D.E. size.
130 lb. sheets .. ..	24	220	400	
210 lb. sheets .. ..	24	220	400	
Paper, printing :				
Ahmadābādī, 74 lb. reams ..	..	250	300	
Bank post, heavy and light each reams .. ..	..	1	2	
Hollingworth, 80 lb. reams ..	1	3	6	Lesser quantities of white, black and other colours.
Rag litho, 67 lb. reams ..	..	5	10	
Tracing, 40" × 30" Qrs. ..	1	12	10	
Pencils :				
"Mongol" Nos. .. ..	8	72	96	
Blue ( sky ) Nos. .. ..	4	36	48	
Brown Nos. .. ..	4	36	48	
Purple Nos. .. ..	4	28	40	
Pink, light green, dark blue, red each Nos. .. ..	3	27	36	
Pencils H and 2, 3, 4, 6 H each Doz. .. ..	2	8	..	
Tape, durex, $\frac{1}{2}$ " × 10 yds. Rolls..	2	10	24	
SURVEY OF INDIA STORES				
<i>Sections I, II, III</i>				
Height indicators ( scales as required ) .. ..	5	44	25	
Tables :				
Chambers, mathematical ..	1	3	2	
Shortredes, logs .. ..	1	3	3	
<i>Section IV</i>				
Barometers, pocket .. ..	1	3	2	
Bars, micrometer, parallax ..	1	8	6	
Bars subtense ( of sizes ) ..	1	7	5	

( *contd.* )

TABLE M.—( *contd.* )*Some Important items of War Equipment and Stores*

Item	Typical H.Q.	Typical Coy.	Park Section	REMARKS
SURVEY OF INDIA STORES—( <i>contd.</i> )				
<i>Section IV—contd.</i>				
Bases, Hunter short ..	1	4	2	
Beacons, triangulation ..	..	18	10	
Boxes, mule. <i>Pairs</i> ..	3	35	10	
Chains, crinoline :				
100 yds. .. ..	1	5	4	
110 yds. .. ..	1	5	4	
Chains, 66 ft. .. ..	4	30	20	
Clinometers, survey pattern ..	4	39	20	
Compasses :				
Beam, of sorts .. ..	2	12	8	
Bow, pump .. ..	5	40	6	
Spring, pen .. ..	4	31	4	
Rectangular magnetic ..	4	39	20	
Proportional :				
Large .. ..	..	3	2	
Ordinary .. ..	3	21	6	
Dividers :				
Spring, small .. ..	2	20	6	
Hair spring, 5" or 6" ..	9	49	20	
Heliotropes :				
5" or 6" .. ..	2	16	6	
12" .. ..	..	..	6	
Instruments, drawing :				
No. 1 set .. ..	1	7	2	
No. 2 set .. ..	1	7	2	
Levels, Zeiss, small ..	1	1	1	
Machines :				
Calculating .. ..	1	5	2	
Do. Twin .. ..	..	1	..	
Pens, drawing .. ..	11	63	20	

( *contd.* )

TABLE M—( *contd.* )*Some Important items of War Equipment and Stores*

Item	Typical H.Q.	Typical Coy.	Park Section	REMARKS
SURVEY OF INDIA STORES— <i>contd.</i>				
<i>Section IV—concl.</i>				
Plane-tables :				
24"×20" .. ..	1	34	8	
30"×24" .. ..	3	5	4	
Rules, sight :				
24" .. ..	1	38	8	
30" .. ..	4	6	4	
Scales, cardboard .. ..	26	130	200	
Staves, levelling .. ..	2	2	2	
Stereoscopes, topo :				
M.I.O. pattern .. ..	1	10	4	
Wooden, head pattern .. ..	5	18	9	
Tapes, measuring :				
50 ft. ( metallic ) .. ..	3	15	8	
100 ft. ( steel ) .. ..	1	12	3	
Theodolites :				
Glass arc .. ..	1	6	3	
Vernier ( 4" to 6" ) .. ..	1	4	4	
Micrometer, 5" ... ..	..	2	2	
Type, Gill-sans, sets .. ..	1	4	2	
Watches, chronometer, mean- time .. ..	1	5	2	
<i>Section V</i>				
Cameras, process, portable, 25" lens .. ..	..	1	..	
Room, lenses for .. ..	..	2	..	
Film, Kodakline :				
Rapid, 80 cm.×10 m. Rolls .. ..	..	4	..	
Slow Rolls .. ..	..	4	..	
Frames, printing, pneumatic, D.E. size .. ..	..	2	..	
Glasses, sheet, negative :				
24"×22" .. ..	..	50	..	

( *contd.* )



TABLE M—( *contd.* )*Some Important items of War Equipment and Stores*

Item	Typical H.Q.	Typical Coy.	Park Section	REMARKS
SURVEY OF INDIA STORES— <i>contd.</i>				
<i>Section V—contd.</i>				
Glasses, sheet, negative :				
36" × 24" .. ..	..	100	..	
42" × 28" .. ..	..	40	..	
Lamps :				
Electric arc single point, pairs ..	..	4	..	
Bulbs "photo flood" 110 V. and 220 V. each .. ..	..	32	..	
Machines :				
Rotary offset D.D. size .. ..	..	2	..	
Paper cutting ( Guillotine ) .. ..	..	1	..	
Paper cutting hand shear .. ..	..	1	..	
Whirler .. ..	..	1	..	
Paper :				
Photo, bromide 25" × 10' Rolls .. ..	..	6	..	
Kodakline rapid 80 cm. × 10 m. Rolls .. ..	..	3	..	
Kodakline slow 80 cm. × 10 m. Rolls .. ..	..	3	..	
Plan boards :				
Pneumatic .. ..	..	1	..	
Non-pneumatic .. ..	..	1	..	
Plates, zinc :				
D.E. size .. ..	..	50	..	
D.D. size .. ..	..	200	..	
23" × 21" .. ..	..	176	..	
Presses, hand D.E. size :				
Transfer proving .. ..	..	1	..	
Proving reversing .. ..	..	1	..	
24" × 22" .. ..	..	2	..	
Trough, graining :				
D.E. size ( power ) .. ..	..	1	..	
„ ( hand ) .. ..	..	1	..	

( *contd.* )

TABLE M—( *contd.* )*Some Important items of War Equipment and Stores*

Item	Typical H.Q.	Typical Coy.	Park Section	REMARKS
SURVEY OF INDIA STORES— <i>concl.</i>  <i>Section V—concl.</i>				
Sets, petrol ( or diesel ), electric, small .. ..	..	3	..	May be one large set in lieu.

*Sections VI and VII stores are omitted**List of Professional Forms*

Indent for forms .. ..	1	10	10
Cover for 11 Lamb. angle book. .	2	15	15
Form No. 3(a) Topo. Wild angle book ( peace ) .. ..	2	40	40
Form No. 13 Topo. C.M.Z.D. Lat.	3	15	15
Form No. 14 Topo. polaris Lat.	3	15	15
Form No. 15 Topo. Time ..	3	15	15
Form No. 17 Topo. Clino Hts. ..	5	40	40
18 Topo. Baro. and Hyps. Hts.	5	25	25
22 Topo. Village list ..	7	30	30
13A Trian. .. ..	..	10	10
16 Trian. Ht., and Refn. G.T. ..	..	10	10
18 Trian. Two sides and incl. angle .. ..	6	30	30
1 Lamb. Dedn. spher-grid ..	10	60	60
2 Lamb. Dedn. grid. spher. ..	5	30	30
3 Lamb. Dist. and bear. from co-ords. .. ..	10	65	65
4 Lamb. Log sides. Triang. ..	20	150	150
4a Lamb. Triang. and co-ords. Comb. .. ..	50	500	500
5 Lamb. Co-ords. and hts. ..	30	250	250
6 Lamb. Cutting pts. and hts.	20	140	140
7 Lamb. Grid Bearing, Sun H. and V. .. ..	15	100	100

( *contd.* )

TABLE M.—(*contd.*)*Some Important items of War Equipment and Stores*

Item	Typical H.Q.	Typical Coy.	Park Section	REMARKS
<i>List of Professional Forms—contd.</i>				
8 Lamb. Grid Bearing, Polaris T. and L. .. ..	15	100	100	
8b Lamb. Grid Bearing, Polaris H. and V. .. ..	10	50	50	
9 Lamb. List co-ords. and hts.	40	360	360	
10 Lamb. Descriptions ..	10	60	60	Pads of 50.
11 Lamb. Angle book ..	20	150	150	Pads of 50.
12a Lamb. Satellite Corrn. ..	25	200	200	
13 Lamb. Bearing, Sun, Time and Lat. known .. ..	10	50	50	
20 Lamb. Trav. Fd. Bk. of 20 pages .. ..	3	25	25	
21 Lamb. Trav. Set-up ..	10	55	55	
22 Lamb. Trav. Comp. Logs ..	5	35	35	
23 Lamb. Trav. Comp. Tables ..	5	35	35	
24 Lamb. Trav. Synopsis ..	5	35	35	
2(a) Trav. Fd. Bk. cover ..	3	20	20	
28(a) Trav. 1-in. squares ..	10	50	50	
1 Sec. 1-10 in. squares ..	5	90	90	
3 Sec. 1-25-in. squares ..	5	30	30	
Resection paper, pads of 100 ..	3	15	15	
Books, computing, log forms ..	3	25	25	
<i>Machine Forms</i>				
1 Mach. Spherical to Grid ..	10	60	60	
2 Mach. Grid to Spherical ..	5	30	30	
3 Mach. Dist. and bearing ..	10	65	65	
4 Mach. Triangles ..	20	150	150	
5 Mach. Co-ords. and heights ..	30	180	180	
6 Mach. Semigraphic resection	20	140	140	
7 Mach. Sun bearing ( H. and V. )	15	100	100	

( *contd.* )

TABLE M.—( *concl.* )*Some Important items of War Equipment and Stores*

Item	Typical H.Q.	Typical Coy.	Park Section	REMARKS
<i>Machine Forms—concl.</i>				
8 Mach. Polaris, bearing ( H. and V. and Time ) ..	15	100	100	Pads of 50.
13 Mach. Sun bearing ( Time ) ..	10	50	50	
14 Mach. Spherical Grid ..	20	20	200	
15 Mach. Hunter Base redn. ..	2	8	4	
16 Mach. Height and refraction	5	40	40	
17 Mach. Soln. of co-ords. and heights .. ..	10	60	60	
18 Mach. 2 side and incl. angle..	3	15	15	
21 Mach. Traverse .. ..	5	35	35	
27 Mach. Map cutting points ..	10	60	60	
28 Mach. Polaris latitude ..	3	15	15	
29 Mach. Circum-meridional latitude .. ..	3	15	15	
30 Mach. Ex-meridional latitude	3	15	15	
31 Mach. Time .. ..	5	30	30	
32 Mach. Conversion of tim ..	15	90	90	
33 Mach. Intersection on Bruns- viga Twin .. ..	10	70	70	
34 Mach. Machine Intersection..	10	60	60	
35 Mach. Interpolation of co-ords.	15	100	100	
Book, computing, machine forms	3	25	25	
<i>Air Survey Forms</i>				
14(a) Air Direct calibration ..	5	40	40	
31 Air True horizon ..	5	50	50	
32 Air Heights .. ..	10	100	100	
32(a) Air Heights ( rapid ) ..	10	100	100	
32(b) Air Horizon correction ..	5	50	50	
32(c) Air Correction to depths ..	5	50	50	

TABLE N.—*Civil Projects completed or*  
( From 1 April 1945 to

Province or State	Name of Project	Scale of Map
1	2	3
<b>A. IRRIGATION AND POWER PROJECTS</b>		
1. Punjab ..	Bhakra Dam ..	32" = 1 m.
2. Punjab ..	Bhakra Rectangulation ..	4" = 1 m.
3. Punjab ..	Thal Rectangulation—Miānwāli Hydel and Pumping Scheme ..	4" = 1 m.
4. Punjab/Kashmīr State ..	Dhiāngarh Dam ..	32" = 1 m.
5. Punjab/Sirmūr State ..	Chandni Dam ..	32" = 1 m.
6. Punjab/Kashmīr State ..	Chenāb Reservoir ..	4" = 1 m.
7. Punjab/Chamba State ..	Marhu Tunnel ..	16" = 1 m.
8. United Provinces ..	Rāmganga Dam ..	32" = 1 m.
9. United Provinces ..	Rāmganga Reservoir ..	..
10. United Provinces ..	Nayār Dam ..	16" = 1 m.
11. United Provinces ..	Nayār Reservoir ( Extension ) ..	4" = 1 m.
12. United Provinces/Sirmūr State ..	Keshau Dam ( c ) ..	32" = 1 m.
13. United Provinces/Sirmūr State ..	Tons Reservoir ( c ) ..	4" = 1 m.
14. United Provinces ..	Kālsi Keshau Road map ( c ) ..	4" = 1 m.
15. United Provinces/Sirmūr State ..	Kālsi Dam ( c ) ..	32" = 1 m.
16. United Provinces/C.I. States ..	Rihand Reservoir ..	2" = 1 m.
17. Nepāl ..	Kosi Dam ..	32" = 1 m.
18. Nepāl ..	Kosi Reservoir ..	4" = 1 m.
19. Bihār/Nepāl ..	Kosi Irrigation ( Commanded Area ) ..	4" = 1 m.
20. Bengal ..	Tista Dam ..	32" = 1 m.
21. Bengal/Sikkim State ..	Tista Reservoir ..	6" = 1 m.
22. Bengal ..	Tista Irrigation ( Commanded Area ) ..	4" = 1 m.
23. Bengal ..	Lower Tista ..	..
24. Bengal/Assam ..	Karnaphuli Reservoir ..	6" = 1 m.
25. Orissa ..	Mahānadi Project—Naraj Dam ..	16" = 1 m.
26. Orissa ..	Mahānadi Project—Tikarpāra Dam ..	16" = 1 m.
27. Orissa ..	Mahānadi Project—Hirākud Dam ..	16" = 1 m.
28. Orissa ..	Mahānadi Project—Hirākud Reser- voir ..	4" = 1 m.
29. Orissa ..	Mahānadi Project—Irrigation ( Com- manded Area ) ..	4" = 1 m.
30. Kotah and Udaipur States ..	Chambal Reservoir ..	..
31. Jodhpur State ..	Jawai River—Erinpura Reservoirs ..	6" = 1 m.
32. Jodhpur State ..	Jawai River—Rectangulation ..	10" = 1 m.
<b>B. SETTLEMENT SURVEYS</b>		
33. Punjab ..	Kulu re-settlement ..	..
34. United Provinces ..	Almora Settlement ..	32" = 1 m. 64" = 1 m.

*in hand during 1945-46*

31 March 1946 )

Scale of Mosaic	Area for Survey (sq. mile)	Completed or in hand	REMARKS
4	5	6	7
..	3	Completed	
..	377 (a)	In hand	(a) In this season. 25-acre rectangulation.
..	279 (b)	In hand	(b) In this season. 20-acre rectangulation.
..	6	Completed	
..	4	In hand	
..	75	In hand	
..	0.5	In hand	
..	1	In hand	
4" = 1 m.	..	In hand	Contoured mosaic only.
..	5	In hand	
5" = 1 m.	..	In hand	Contoured mosaic and map.
..	4	Completed	(c) Prepared for Punjab Government.
..	30	In hand	
..	34	Completed	
..	1	Completed	
..	600	Completed	Prepared for U.P. Government.
..	1	In hand	
..	118	In hand	
..	6,000	In hand	
..	4	In hand	
..	47	In hand	
..	10,000	In hand	
6" = 1 m.	150	In hand	Uncontoured photo mosaic only.
..	350	In hand	
..	6	In hand	
..	1	In hand	
..	8	In hand	
..	360	In hand	
..	2,200	In hand	
2.08" = 1 m.	300	Completed	Contoured mosaic only.
6" = 1 m.	48	Completed	Line map of main reservoir of area 28 sq. miles and contoured mosaics of the whole area completed.
3" = 1 m.	180	In hand	Uncontoured mosaic (180 sq. miles) completed. Ground work for maps in hand.
..	260	In hand	Points fixed and plotted on field sheets ( <i>musavis</i> ) on a scale of 57" = 1 mile.
..	0.3	Completed	Experimental survey only.

(contd.)

TABLE N.—*Civil Projects completed or*  
( From 1 April 1945 to

Province or State	Name of Project	Scale of Map
1	2	3

C. LAND RECLAMATION AND SOIL CONSERVATION PROJECTS

35. Punjab	..	Kariala Soil Conservation	..	..
36. Punjab	..	Gujar Khān anti-erosion Survey	..	..
37. United Provinces	..	Tarai Land Reclamation	..	..
38. Rāmpur State	..	Rāmpur Land Reclamation	..	16" = 1 m.

D. SURVEYS FOR GEOLOGICAL PROJECTS

39. Bihār	..	Bokāro Coal-field	..	4" = 1 m.
40. Bihār	..	Giridīh Coal-field	..	4" = 1 m.
41. Central Provinces and Berār	..	Kamptee Coal-field	..	4" = 1 m.
42. Central India States	..	Son Valley	..	2" = 1 m.
43. Central India States	..	Umaria and Karar Coal-field	..	2" = 1 m.
44. Central India States	..	Johilla River Coal-field	..	2" = 1 m.
45. Hyderābād State	..	Rajladila Iron Ore Project	..	4" = 1 m.
46. Punjab	..	Ranotra	..	2" = 1 m.

E. MISCELLANEOUS PROJECTS

47. United Provinces	..	Ganges River—Bithur to Cawnpore	..	..
48. Bihār	..	Ganges River Crossing at Patna and Mokameh	..	..
49. Bihār	..	Sindri Factory	..	16" = 1 m.
50. Bengal	..	Hooghly Ship Canal	..	..
51. Assam	..	Goālpāra	..	..
52. Assam	..	Beki-Manās Basin	..	..
53. Jodhpur State	..	Jodhpur Railway Crossings	..	..
54. Hyderābād State	..	Maithani Bijapur Rly. Alignment	..	..

F. TOWN PLANNING

55. Delhi	..	New Delhi Development Survey	..	100' = 1"
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G. TOPOGRAPHICAL SURVEYS

56. Bombay/Deccan States	..	Bombay & Deccan States	..	1" = 1 m.
57. Assam	..	Bālipāra Frontier Tract	..	1" = 1 m.
58. Assam	..	Walong ( 91 D & H )	..	2" = 1 m.

*in hand during 1945-46—( conclud. )*

31 March 1946 )

Scale of Mosaic	Area for Survey ( sq. mile )	Completed or in hand	REMARKS
4	5	6	7

15·4" = 1 m.	9	Completed	Uncontoured mosaic only.
2" = 1 m.	1,800	Completed	Uncontoured mosaic only.
4" = 1 m.	305	In hand	Uncontoured photo mosaic only.
..	6	Completed	Original unpublished ground survey section supplied.
..	396	In hand	
..	19	In hand	Only photography completed.
..	384	In hand	
..	21,000	In hand	Ground control for 3,000 sq. miles completed.
..	238	In hand	Only photography completed.
..	53	In hand	Only photography completed.
..	81	In hand	Only photography required.
..	900	Completed	Air photography only.
3·5" = 1 m.	42	Completed	Uncontoured photo mosaic only.
2" = 1 m.	570	Completed	Uncontoured photo mosaic only.
..	6	In hand	
6" = 1 m.	90	In hand	Uncontoured photo mosaic only.
5·7" = 1 m.	76	Completed	Uncontoured photo mosaic only.
1·4" = 1 m.	280	Completed	Uncontoured photo mosaic only.
6" = 1 m.	224	Completed	Uncontoured photo mosaic only.
..	..	Completed	Air photography only.
..	27	In hand	
..	480	In hand	
..	870	In hand	
..	22	Completed	

